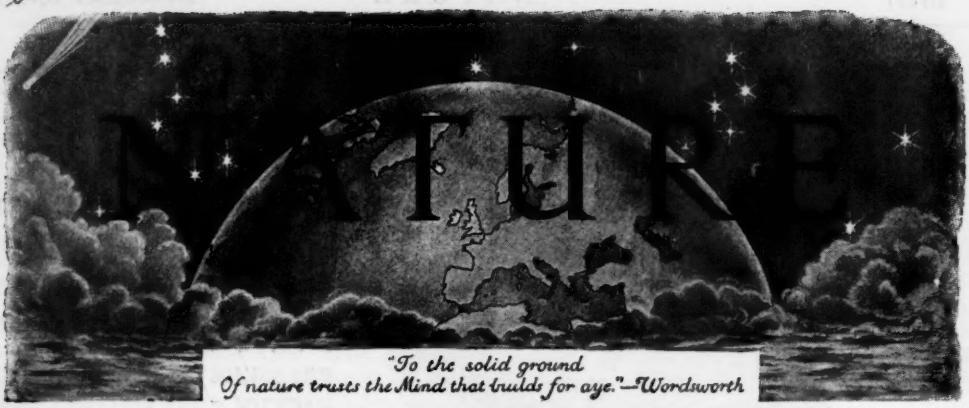
Desk

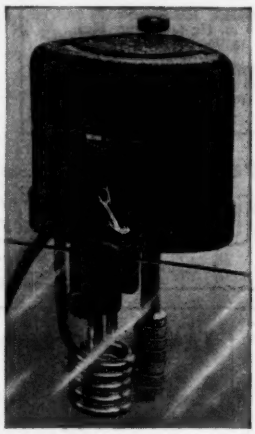



VOL. 178, No. 4545 SATURDAY, DECEMBER 8, 1956 TWO SHILLINGS


## TECHNE TEMPUNIT

The Techne Tempunit is a self-contained constant temperature control for fitting to any vessel.

- Indicating Thermostat.
- Patented pneumatic control.
- ± .05°C. in unlagged 4 gallon bath over the range, room temperature to 90°C.
- Circulation to external apparatus.
- Brushless silent motor.
- Rugged solid drawn 1000w. heater.
- Efficient stirrer.
- Available for 200/250v., 50 cycle a.c. or 100/120v., 50/60 cycle a.c. supply.



TECAM

*for full details write or telephone*

TECHNE (CAMBRIDGE) LTD.,
DUXFORD, CAMBRIDGE, ENGLAND Tel: Sawston 246

Tinsley

## STANDARD CADMIUM CELLS

Single and double types in wooden cases or in metal cases as illustrated.

Reliable single or double miniature types mounted in plastic cases, E.M.F. 1.01859 abs. volts at 20°C. Temp. coeff.—40 μV/1°C. Low internal resistance.

Dimensions 3¼ in. × 1⅜ in. × 1 3/16 in.

Non-temperature coefficient cells for industrial use.

All types of unmounted standard cells can be supplied in quantity from stock.

H. Tinsley & Co. Ltd., Werndee Hall
London, S.E.25
Telephone: ADDiscombe 6046-7-8


UNIVERSITY OF MICHIGAN
DEC 27 1956
PERIODICAL READING ROOM


MSE

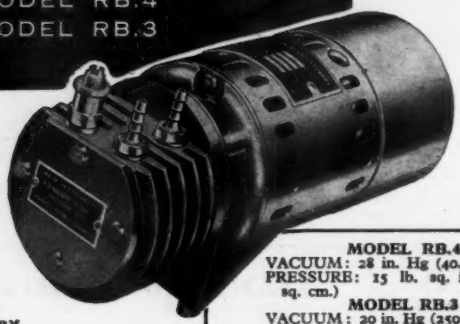
## "SUPERSPEED 20" CENTRIFUGE

NEW

Push Button Control
20,000 R.P.M.
45,000 × g
Controlled Temperature

MEASURING & SCIENTIFIC EQUIPMENT LTD.
SPENSER STREET, LONDON, S.W.1. Telephone: VICtoria 5426

'SPEEDIVAC'
COMBINED VACUUM-PRESSURE UNITS
MODEL RB.4
MODEL RB.3



EARLY DELIVERY

MODEL RB.4
VACUUM: 28 in. Hg (40.0 mm. Hg)
PRESSURE: 15 lb. sq. in. (1.0 kg. sq. cm.)
MODEL RB.3
VACUUM: 20 in. Hg (250.0 mm. Hg)
PRESSURE: 10 lb. sq. in. (0.7 kg. sq. cm.)

**There are no two ways about it . . .**

**TWO EXCELLENT SERVICES FROM ONE UNIT**

Both are indispensable and reliable services in the laboratory and factory . . . a moderate, non-fluctuating PRESSURE service and a very efficient VACUUM.

Compact . . . easily carried by hand . . . sturdy enough to be incorporated in production plant . . or to deal with the 10 laboratory jobs.

*For better vacuum service . . .*

**EDWARDS HIGH VACUUM LTD**

MANOR ROYAL · CRAWLEY · SUSSEX CRAWLEY 1500 (10 LINES) EDCOHIVAC CRAWLEY

BRANCHES: GLASGOW · TORONTO & MILAN
AGENTS THROUGHOUT THE WORLD

*"The Stopcock People"*
introduce the NEW

**GREASELESS STOPCOCK**

(PAT. APP. 26076)

- NO GREASES • HIGH VACUUM
- RANGE – 80°C to 250°C
- ON/OFF OR VERY FINE CONTROL
- ALL GLASS BODY
- INTERCHANGEABLE COMPONENTS

*Descriptive leaflet on application to :*

G. SPRINGHAM & CO.
HARLOW NEW TOWN
ESSEX

EST. 1932 *"The Stopcock People"* HARLOW 24108

***The Answer to a common Problem . . .***

The Pumpett fills and empties pipettes of any size and type—bulb, graduated or capillary—with utmost precision and positive control as to volume and speed. A unique feature is the independent micro control, which permits critical adjustment of micro capillary pipettes.

PUMPETT
AUTOMATIC
PIPETTE CONTROL

*The Pumpett, of which thousands are in use already, is now available for prompt delivery—why not give it a trial?*

SHANDON

SHANDON SCIENTIFIC COMPANY LTD.
6, CROMWELL PLACE, LONDON, S.W.7. Tel: KNightsbridge 1

# NATURE

No. 4545 SATURDAY, DECEMBER 8, 1956 Vol. 178

## CONTENTS

| | Page |
|---|---|
| Deployment of Scientific Man-power in Britain | 1255 |
| Sir John Russell, F.R.S. By the Right Hon. Viscount Bledisloe, P.C., G.C.M.G., K.B.E. | 1257 |
| Education of the Layman in Atomic Energy. By Dr. S. C. Curran, F.R.S. | 1258 |
| Biology and Medicine of Atomic Warfare. By Dr. J. F. Loutit | 1259 |
| Building : Myths and Magic. By Dr. E. J. Dingwall | 1259 |
| Botany of British Hills. By Prof. J. Heslop-Harrison | 1260 |
| The Royal Society: Anniversary Address by Sir Cyril Hinshelwood, F.R.S. | 1261 |
| Obituaries: | |
| Prof. Winifred Cullis, C.B.E. By Dr. M. Bond | 1266 |
| Dr. A. L. Clark. By Dr. H. G. Conn | 1267 |
| News and Views | 1267 |
| New Mauna Loa Observatory Unit. By Roy L. Fox | 1272 |
| African Vegetation: Meeting at Yangambi. By R. W. J. Keay | 1273 |
| Ninth International Congress of Applied Mechanics | 1274 |
| The Nuclei of Atmospheric Condensation. By Dr. B. J. Mason | 1274 |
| World Telecommunication. By Prof. J. Greig | 1276 |
| City and Guilds of London Institute | 1277 |
| Nitrogen Metabolism as affected by Potassium Deficiency | 1277 |
| Physiology of Muscle. By Prof. D. C. Harrison | 1278 |
| Sensitivity of Immature Mouse Sperm to the Mutagenic Effects of X-Rays. By Dr. A. J. Bateman | 1278 |
| A Disturbing Factor in Very High Frequency Communications via Ionospheric Forward Scatter. By D. A. Crow, F. A. Kitchen, G. A. Isted and G. Millington | 1280 |
| Distribution of Anthocyanin Pigments in Poppies. By Dr. R. M. Acheson, Dr. John L. Harper and I. H. McNaughton | 1283 |
| Letters to the Editors: | |
| The Cones of the Grass Snake's Eye.—Dr. K. Tansley and Dr. B. K. Johnson | 1285 |
| Survival of the Heart following Deep Hypothermia.—Prof. J. Giaja and J. Radulovic | 1286 |
| Effect of Surface-active Agents on the Living Cell.—Dr. Helen Goldhammer | 1286 |
| Serum Protein Differences between Africans and Caucasians.—Dr. H. Eldon Sutton, James V. Neel, G. Binson and Wolf W. Zuelzer | 1287 |
| Reversible Degradation of Adenosine Triphosphate to Inosinic Acid during a Single Muscle Twitch.—(The late) J. Wajzer, Rolf Weber, J. Lerique and J. Nekhorocheff | 1287 |
| A Complement-fixation Reaction with *Haemobartonella muris* and *Eperythrozoon coccoides*.—Dr. R. Wigand | 1288 |
| Role of a D-glucosamine as Inhibitor of the Precipitation of Blood Group Substances by Anti-Type XIV Pneumococcus Serum.—Dr. Winifred M. Watkins and Prof. W. T. J. Morgan, F.R.S. | 1289 |
| Effect of Butyrate Administration on Blood Glucose in Sheep.—D. S. Kronfeld | 1290 |
| Acquired Resistance to Chloroquine Diphosphate in *P. gallinaceum* in Chicks.—A. P. Ray and G. K. Sharma | 1291 |
| Enhancement of Activity in a Pacinian Corpuscle by Sympathomimetic Agents.—Dr. W. R. Loewenstein and R. Altamirano-Orrego | 1292 |
| Binding of Histamine in Mammalian Tissues.—R. K. Sanyal and Dr. G. B. West | 1293 |
| Enzyme-Substrate Complex Formation: a First Stage in Ribonuclease Activity.—Prof. Anwar A. Hakim | 1293 |
| Distribution in the Soft Tissue of the Rat of Radioactive Fluoride administered as Sodium Fluoride.—John W. Hein, John F. Bonner, Finn Brudevold, Prof. Frank A. Smith and Harold C. Hodge | 1295 |
| Occurrence of 'Lumps' of Coagulated Material in the Bladders of Adrenalectomized Guinea Pigs.—Barbara E. Clayton, Joyce E. Hammant and Joyce B. Hawkins | 1296 |
| Communal Oviposition in *Simulium damnosum* Theobald (Diptera, Simuliidae).—Dr. R. C. Muirhead-Thomson | 1297 |
| Effect of Changes in Humidity on the Toxicity and Distribution of Insecticides sorbed by some Dried Soils.—F. Barlow and A. B. Hadaway | 1299 |
| Reactions to Shading in the Sea Urchin *Psammechinus miliaris* (Gmelin).—Prof. N. Millott and M. Yoshida | 1300 |
| Plastochron Determination in *Ranunculus* using Carbon-14 Dioxide—Dr. F. J. F. Fisher | 1300 |
| Chasmogamous Flowering in *Viola palustris* L.—L. T. Evans | 1301 |
| Control of Watercress Crook Root Disease by Zinc-fritted Glass.—Dr. J. A. Tomlinson | 1301 |
| Molybdenum Deficiency in Hops.—Joyce Watson and H. O. Askew | 1302 |
| The Olivine–Spinel Transition in the Earth's Mantle.—Dr. A. E. Ringwood; Prof. F. A. Vening Meinesz, For.Mem.R.S. | 1303 |
| Surface Adhesion and Elastic Properties of Mica.—George L. Gaines, jun., and Dr. David Tabor | 1304 |
| Dependence of the Dielectric Breakdown of Transformer Oil on Electrode Conditions—Dr. R. Hancox | 1305 |
| Photochemical Conversion of Triethyl-tin to Diethyl-tin.—Dr. W. N. Aldridge and Jill E. Cremer | 1306 |
| A Method of promoting Water-forming Organic Reactions.—J. Kollonitsch and J. Vita | 1307 |
| A Small Mercury Cut-off withstanding Large Pressure Differences.—H. Block | 1307 |
| A Theory of Word-Frequency Distribution.—A. F. Parker-Rhodes and T. Joyce | 1308 |

DIFCO

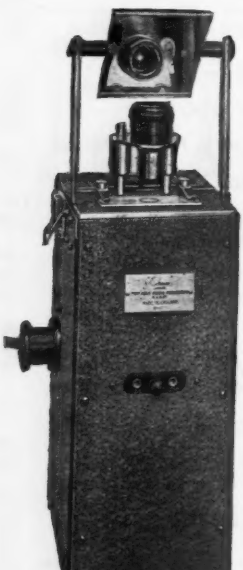
# CULTURE MEDIA FOR FUNGI

This group of Dehydrated Culture Media, Difco, is prepared expressly for propagation of the fungi most frequently encountered in phytopathological studies. Each medium is readily prepared for use and requires no adjustment of its reaction or filtration of the solution.

**Bacto-Bean Pod Agar**
**Bacto-Corn Meal Agar**
**Bacto-Lima Bean Agar**
**Bacto-Malt Agar**
**Bacto-Potato Dextrose Agar**
**Bacto-Prune Agar**
**Bacto-Wort Agar**
**Bacto-Malt Extract Broth**

**Specify "DIFCO"**
**THE TRADE NAME OF THE PIONEERS**
in the Research and Development of Bacto-Peptone and Dehydrated Culture Media

*Sole Agents for Gt. Britain*
**BAIRD & TATLOCK (LONDON) LTD.**
**FRESHWATER ROAD, CHADWELL HEATH, ESSEX**



*Enbeeco*
# PORTABLE MICRO PROJECTOR

**The use of standard precision-made British optical elements, combined with ingenuity and simplicity in design, permits this robust instrument to be offered at a price well within the reach of all.**

- **Projection: 38 mm. Leech achromatic microscopic objective.**
- **Spiral focusing movement.**
- **Illumination: 12 v. 100 watt twin pillar vertical centre projection bulb.**
- **50× enlargement at 6'; 100× at 12'.**
- **Operative from mains current 200–250 v. A.C.**
- **Even and brilliantly illuminated field.**
- **Price £27.10.0**

*Fuller details gladly sent on request.*

**NEWBOLD & BULFORD LTD**
ESTABLISHED 1796
*Manufacturers and Exporters of Optical and Scientific Instruments and Ophthalmic Supplies etc.*
ENBEECO HOUSE, ROGER ST., GRAYS INN RD., W.C.1.
TELEGRAMS: CHANCERY 5041 (3 LINES) TELEGRAMS: BULFORD, PHONE, LONDON
"Enbeeco" PRODUCTS DISTRIBUTED BY LEECH (SCI) PRODUCTS

INORGANIC QUALITATIVE ANALYSIS:

# SEMI-MICRO METHODS

BY

H. HOLNESS

M.Sc., F.R.I.C., Senior Lecturer in Chemistry, South-West Essex Technical College

SECOND EDITION

This is an essentially practical book to be used "on the bench". The whole work has been thoroughly tested in practice and every experiment described has been tried out with classes of students. All students, up to and including those sitting for the B.Sc. general examination in chemistry for London University, will find this a valuable book. Illustrated. 12*s.* 6*d.*

**PITMAN**

Parker Street . Kingsway . London, W.C.2

# DEPLOYMENT OF SCIENTIFIC MAN-POWER IN BRITAIN

THE central theme with which the Advisory Council on Scientific Policy has been concerned during the past year or more is that of scientific man-power in Britain. The results of two inquiries by the Council's Committee on Scientific Man-power have already been published as separate reports. The ninth annual report of the Council, recently issued*, which covers the fifteen months from April 1955 to June 1956, inclusive, is devoted mainly to other matters with which the Council has been concerned; apart from a brief note in which the Council welcomes the Government's announcement of its plans for the expansion of technical education and also the prospect of substantial new developments in the universities during the next quinquennium. Nevertheless, the problem of scientific man-power may be said to provide indirectly the keynote of even the present report.

It is true that, as the Council remarks in this report, everything possible also needs to be done to ensure, by adequate provision for the secondary schools, that there are enough potential students of the right quality to take full and proper advantage of the increased provision for higher education in the pure and engineering sciences. It is no less true, however, that the nation's demand for scientific man-power, in both the pure and the applied sciences, depends on the efficiency with which that man-power is used. It is right that the recent White Paper on the Factory Inspectorate should stress the importance of making sure that at the present time, neither in government departments nor in industry, nor, it might be added, in the universities or in teaching, should a highly trained scientist or technologist be employed on duties which do not make reasonably full use of his or her special qualifications and knowledge. It is well that the Service Ministries should be pressed hard in Parliament as to the duties on which they employ science and engineering graduates, and that there should be other evidence that it is at last being recognized in industry and elsewhere that such scarce knowledge and skills are to be used with due forethought and economy.

The wise and economic use of scientific man-power depends also on the provision both of ancillary technical assistance and of the requisite aids and equipment. The ninth annual report of the Advisory Council on Scientific Policy does not refer to the former, though, in view of the lacuna in this respect in both the White Paper on Technical Education and the more recent report on Scientific and Engineering Man-power in Great Britain, it might well have been expected to do so if only to clarify the distinction between technical and technological education, and to emphasize that there is need of a really large expansion in the number of technicians. More technicians are undoubtedly needed to ensure that existing resources in scientific and technological man-power are used efficiently, let alone the increased numbers which the expanded facilities for technological and scientific training should provide. There is still very real danger that the expansion of the technical colleges in Britain may be so conducted as to hinder their primary function of providing the necessary technicians, and that the effect of an increase in the number of technologists and scientists may be more than offset by the absence of a sufficient force of supporting technicians.

This ninth annual report is, however, concerned with various aspects of the provision of the ancillary aids, and its common theme might be said to be the provision of means to make more effective use of scientific and technological man-power in Britain. This may not be directly true of the detailed study of the various systems of training engineers in different countries which, with the help of other interested bodies, the Advisory Council is seeking to arrange; but by providing, as the Council believes it would, useful guidance in the development of technological education, this study could well contribute to an increase in the efficiency of technological education, even if it pointed to no economy in man-power there. Even in the United Kingdom, there is a wide range of technical qualifications and methods of training technologists, and there is abundant evidence of muddled thinking, not least in Government circles, about technological education, which such a study could at least help to remove.

Much more serious, however, is the matter of the National Scientific Reference and Lending Library projects. In its eighth annual report, the Advisory Council emphasized once again the importance which it attached to an adequate national service of scientific reference and lending libraries as an essential tool in disseminating the results of scientific research to industrial and other users; and since then there has been strong support for the Advisory Council's view —particularly at the recent conference of the Library Association—some of it referring to the bearing of these projects on the efficient use of scientific and technological man-power.

The Advisory Council's hope that the Government would give firm decisions in favour of an early start on both projects has again been disappointed. Once more the Council has to report that no progress has been made; provision of £2,500 in the current estimates for the purchase of literature for the future National Scientific Lending Library, to be housed for the present in the Science Museum Library in South Kensington, points to a complete failure on the part of the Government to appreciate the vital bearing of ancillary aids on the economic use of scientific man-power. For lack of the material service recommended by the Advisory Council, it is probable that scientific

* Ninth Annual Report of the Advisory Council on Scientific Policy. (London: H.M. Stationery Office, 1956.) 1s. 6d. net.

effort representing many times that £2,500 is wasted every year, and there is no sign as yet that the Government is prepared to take any step to arrest this wastage of one of our most precious assets.

The Advisory Council has been informed that a decision has been taken to place ultimate responsibility for the National Science Lending Library on the Department of Scientific and Industrial Research, and the Department has been authorized to start planning such a library. The Council accordingly hopes that another year will not pass without some concrete evidence that its recommendations are being put into effect. There is no indication, however, that any action is contemplated about the Reference Library project. Moreover, the full advantage of neither project can be gained if it is planned and executed in isolation or without regard to the building up of an appropriate supporting regional system. No confidence can be entertained in the Government's intentions until it takes up these schemes as part of the Science Centre project, and allocates the sum required to make this essential contribution to the efficient use of our resources in scientific and technical man-power.

The Advisory Council, which should certainly be thinking about its next step, does not leave it at that. It cites the difficulty of handling the ever-increasing output of Russian scientific and technical literature as an example of the inadequacy of the national scientific library service in Britain. No simple recipe for dealing with this problem is offered. The Advisory Council is content to outline the main components of the problem as a basis for discussion, but is careful not to divorce its solution from the long-overdue general modernization of library and information service for all scientific and technical literature. The importance of various factors—the extent to which Russian is read and the encouragement of the teaching of Russian as an important modern language in schools and universities, the securing of Russian scientific literature and making it available, its dissemination and translation—varies, but the problems are not unique and apply in varying degrees to literature in Chinese, Japanese and other languages. Since the Department of Scientific and Industrial Research already runs a limited translating service for Russian scientific periodicals and is to be responsible for planning the proposed National Scientific Lending Library, the Advisory Council has invited the Department to survey existing facilities and to consider what additional arrangements are required. This investigation, in consultation with the Advisory Council's Scientific Library and Technical Information Committee, is already under way.

Of a different order are the proposals to establish a national research centre at which a number of high-energy particle accelerators might be installed to provide research facilities for teams from universities and other institutions concerned with nuclear physics, and to set up in Britain a central mineral-processing laboratory to undertake research into the methods of treating low-grade and complex ores and into chemical and other processes of extractive metallurgy which have been successfully developed. The former proposal, which came to the Council from the Atomic Energy Authority, is under discussion with the university authorities. Various bodies during the past few years have urged the establishment of central facilities for long-range research in the latter field, and the Department of Industrial and Scientific Research is at present discussing with scientific and industrial interests the possibility of establishing such a centre. Although the proposals involve a risk that the centre might monopolize the research facilities available, both schemes offer the possibility of increasing the effectiveness of existing workers in this field by providing them with more adequate equipment and technical assistance.

Of a like nature in its bearing on the effective deployment of scientific man-power is the proposal examined by a working party of the Advisory Council's Biology and Allied Sciences Committee to establish in Britain a centre for tropical agriculture. As territories have become self-governing, British experts in the various agricultural and forestry services have been gradually withdrawn and many have left such territories as Burma and the Sudan, either at their own wish or under pressure from the governments of those territories. If Britain is to help the future development of these newly independent territories, she must be able to provide the training and advice in agricultural matters which they still urgently need; and the working party was convinced that an institution in the United Kingdom is needed both to ensure a future supply of British experts in tropical agriculture, forestry and fisheries, and also as a place which citizens of tropical and sub-tropical countries can use as a base and to which they can turn for advice when studying in Britain.

The need is not for a new college or school for tropical agriculture, the place for which is in the tropics; but for an institute which can help in tackling these problems, and others, such as identifying the most urgent and important problems of research, serving as a channel of communication between agricultural interests in tropical territories and British firms at home and as a meeting place and clearing house for inquiries and advice. The working party was not asked to draw up a plan for such an institute, but the Advisory Council is in broad sympathy with the lines on which the working party suggests the problem should be tackled. In particular, it agrees that the proposed institute, while enjoying support from government sources in Britain as well as from industry and philanthropic institutions, should not be itself a government organization. The working party's report has been submitted to the various Ministers concerned, but it would seem that in view of the potentialities of the proposal for economy in scientific man-power, it could well have been backed by something more tangible than the hope that early consideration will be given to the best means of achieving them.

The remaining two matters discussed in the report —the population problems of tropical countries and

research in independent Commonwealth territories—also bear on the utilization of scientific man-power. The latter problem directly affects the demand for scientific man-power, and the Advisory Council believes it is desirable that the Agricultural and Medical Research Councils and the Department of Scientific and Industrial Research should co-operate in the provision of scientists for work in the independent Commonwealth territories as well as in the Colonial territories, even if it means adjustments in their present powers to operate overseas. These bodies have already been asked to give further thought to the measures necessary, and the Advisory Council is convinced that it is in the best interests of the territories themselves, and of science and scientists in Britain, for British scientists to continue and increase their activities and research in the Commonwealth overseas.

Developments here could increase the demand for scientific man-power in Britain, as well as increase the efficiency with which it is used in some fields. The former matter calls for an increase of expenditure and man-power in a field that will require much work before practical results are obtained. The two main lines of approach to this difficult problem of population growth in tropical countries are social research into problems of family life and social attitudes towards them, and physiological research into the control of fertility and infertility. It is essential to build up a store of knowledge in the latter field, as no artificial means of birth control has any prospect of success unless it is desired by the people who are to use it. The need for financial support from the United Kingdom for research into problems of family life in these territories became urgent during the past year, for American authorities which have been responsible for a large-scale investigation in Puerto Rico wish to extend their studies to other territories, including British Colonies. Money has been made available for such a project in Jamaica, but similar studies are needed elsewhere, and there is no guarantee that any funds will be available after the present Colonial Development and Welfare Act terminates in 1960.

The Advisory Council looks to the Medical Research Council in Britain to proceed as fast as possible with its researches into fertility and infertility and the factors affecting them; but it has hitherto been difficult to persuade sufficient scientists to take up this line of work. Nor does this report suggest any assured prospect of adequate financial support from Government or other sources. Here again is an important field demanding a greater research effort, but one which could ultimately result in the saving of scientific man-power and in the more effective application of scientific and technical knowledge. The Advisory Council on Scientific Policy's ninth annual report displays admirably the bearing of diverse ancillary matters such as equipment and supporting technicians on the demand for scientific man-power and the efficiency with which it is used; but presumably its very terms of reference prevent it from calling for action with the vigour and firmness which the situation demands.

# SIR JOHN RUSSELL, F.R.S.

## The Land Called Me

An Autobiography. By Sir E. John Russell. Pp. vi+286+5 plates. (London: George Allen and Unwin, Ltd., 1956.) 25*s*. net.

I ESTEEM it an honour to be asked in my ninetieth year to review the autobiography of so distinguished and unique a personality as Sir John Russell, acclaimed throughout the English-speaking world—and in many countries outside it—as Britain's outstanding agricultural scientist, and I do so with the greater pride as he was born in a village (Frampton-on-Severn in my own county (Gloucestershire), where his father was a nonconformist minister.

Russell has been unique in his combination of profound scientific knowledge (based upon research and experiment) with an unrivalled capacity for imparting it to others in simple, easily intelligible language, untiring energy, a passion for land development in every part of the world and, above all, deep human sympathy and a yearning for the alleviation of human ills. Well might he say, as Abou Ben Adhem said to the Recording Angel, "Write me as one who loves his fellow men". In view of what became his life's career, it is interesting to note that his youthful zeal as a social reformer while running a mission in the slums of Manchester when a student at Owens Cottage developed in him a craving—albeit without worldly means—to establish an agricultural settlement in the countryside into which its degraded and poverty-stricken slum population could be moved, and with that object he sought, and obtained, a post as a lecturer in chemistry in Wye Agricultural College, Kent.

Russell's social settlement scheme proved impracticable. But this it was which brought him for the first time (at the age of twenty-nine) in touch with agriculture and the land. Thereafter the "Land called" him and eventually placed him in the forefront of its most eminent scientific pioneers. He relates how he never saw a hill without longing to climb to the top of it, and this was true in a moral and intellectual, as well as a physical, sense, the dominating motive being the betterment of humanity and of its chief sources of food. Considering his strenuous professional life, his constant journeys to countries in almost every part of the world and the innumerable lectures which he delivered in them, not to mention his recorded observations of their social, political and economic conditions, are among the surprises of this highly instructive and thrilling narrative, besprinkled with humorous anecdotes and quaint sayings. In almost every country that he visited, honorary degrees and other distinctions were conferred upon him.

Among outstanding landmarks in Russell's amazing career were his appointment in 1907, at the age of thirty-five, as director of Rothamsted Experimental Station, our oldest and greatest agricultural research station, the award of the Albert Gold Medal of the Royal Society of Arts, his presidency of the British Association for the Advancement of Science at its Newcastle meeting in 1949, the celebration of his golden wedding in 1951 in the hall of St. John's College, Oxford, and that of his eightieth birthday in 1952 in the Apothecaries Hall in the City of London, and in 1954 the presentation to him by the Queen of the Gold Medal of the Royal Agricultural Society at the Royal Show at Windsor.

Not the least valuable of his life's assets, as he affectionately testifies, have been a devoted and selfless mother and wife. The eminent autobiographer has proved himself in every sense a great Englishman and a fine exemplar to our rising generation.

BLEDISLOE

---

# EDUCATION OF THE LAYMAN IN ATOMIC ENERGY

## Facing the Atomic Future

By Prof. E. W. Titterton. Pp. xi+379+6 plates. (London: Macmillan and Co., Ltd.; New York: St. Martin's Press, Inc., 1956.) 21*s.* net.

WE have heard a great deal since the advent of the atomic bomb about the social responsibility of scientists and the need for them to teach the public more about the implications of scientific advances. If the scientist is to succeed in this task it is essential that his pupils should be prepared to co-operate with him and to work seriously. At the same time, in the field of education we hear more and more about the importance of preserving breadth in the training of the scientists and technologists through the provision of courses in the humanities. It is not by any means equally obvious to some of our educators that those trained in the humanities should be furnished with a reasonable grounding in science and technology. Indeed, it is alarming to find in some quarters what appears to be a kind of pride in confessing to an almost complete ignorance of science. This situation makes it an extremely difficult, and indeed almost impossible, task to write in an instructive way for a very large cross-section of the educated public. There is a large fraction of those forming the rather nebulous group known as 'intelligent laymen' who have no real grasp of science. To those content to remain in this category there is nothing to be said in favour of the admirable effort of Prof. E. W. Titterton in this volume.

He has written a book which is in no sense superficial in its treatment of a very vast subject, and his book is one which demands concentration on the part of the readers for whom it is primarily intended. In spite of clarity of style, a thorough grasp of the many major topics with which he chooses to deal and the liberal use of analogy, it is, as might be expected, impossible for the author to avoid or gloss over the hard scientific core of the subject. Indeed, the book would fail in its purpose if the author had tried to do so. He chooses then to meet the difficulty fairly and squarely, and he succeeds very well in all the important aspects of his task. Nevertheless, for the reasons already advanced, it is difficult to say with any confidence how far he will achieve the particular aim which is in his mind. The specialist, reasonably conversant with much of the material, will find the exposition a little laboured, whereas the 'intelligent layman' will need to make a determined effort to understand.

It might be questioned whether the author is wise to include so much detail about the existing situation. It is true, as he himself rightly points out, that the great majority of books are out of date; but it is difficult to ensure any really lasting value to a book if it deals very largely with the detailed features of the field, since these may change very rapidly. It could be argued that Prof. Titterton in this book deals somewhat excessively with the present situation and that he includes the particular to an extent which is rather excessive for a book intended for the further education of the 'intelligent layman'.

With these remarks, I have expressed the only doubts that rise to mind. There are many points on which I am perfectly happy. Thinking of the type of reader who is educated in science or engineering, though not necessarily engaged in pursuits specifically involving such education, I can confidently assert that these readers will be rewarded by a careful reading of this volume. It should give them a thoroughly up-to-date and comprehensive knowledge of the many advances that have been made and an idea of those likely to come in the future. They will find a thoughtful attempt to assess these advances in relation to the functioning of society. The same features should make the volume very valuable to those genuinely seeking an understanding—for example, students in extra-mural classes dealing with modern science. Certainly, with a minimum of help from a teacher, the book could become an exceedingly valuable text.

Prof. Titterton divides his volume into three main parts: atoms for peace; atoms for war; and social and political problems of atomic energy. Each part is dealt with in considerable detail, and the first, not unnaturally, accounts for roughly three-fifths of the whole. The second and third parts are roughly equal in length. The author has collected together much of the openly published material on weapons, and he analyses and discusses it in a careful and factual manner. The same approach is made to the social and political problems—he is admirably unemotional in dealing with the many grave issues that are raised. In this part he guides us skilfully through the maze of efforts that have been made to reach international co-operation in the field.

There is another feature of the book that calls for favourable comment. It is difficult to imagine much improvement on Prof. Titterton's selection of facts and figures. Without giving the impression of a pocket encyclopædia in any way, the book contains a very notable store of useful general information in the form of tables. Thus in Chapter 4, on the need for an atomic power source, are found tables giving water-power, coal and oil in terms of geographical location and under a variety of sub-divisions such as annual production and reserves. The tables reveal many interesting and thought-provoking facts such as the power per head of population in various parts of the world. In this respect the book will form a useful addition to the literature, since it has rapidly become increasingly difficult in the great volume of detailed literature on atomic energy to find the more general facts and figures. Prof. Titterton, as befitting the holder of the chair of nuclear physics in the Australian National University, Canberra, gives in some detail the Australian side of the picture.

To the serious reader this book will provide a really comprehensive survey of the subject so far as it has been made available, and it will provide the basis of a well-balanced view of the advances already made and the probable scope in the near future of the field of atomic energy. It will provide him with the background necessary to a continuing appreciation of a very rapidly expanding subject. The serious work of the author deserves serious application on the part of the 'intelligent layman'. Books such as this from practising scientists are the best answer to the call for more education of the public in the specialized

fields. They constitute in turn a challenge to the 'intelligent layman' to fulfil his part of the task. The author's efforts should not be in vain, as the book will provide those with a reasonable grounding in the physical sciences with a straightforward but uniquely comprehensive picture of perhaps the most important field of scientific activity and engineering of the present day. It is refreshing to find a book which shows no tendency to the somewhat hysterical approach to the subject evident in the works of others who aim at catching the attention of the layman. The phase in which there was any justification for such treatment is long past, and a sober factual exposition is now required. The book provides this admirably.

S. C. CURRAN

## BIOLOGY AND MEDICINE OF ATOMIC WARFARE

### Medical Effects of the Atomic Bomb in Japan

Edited by Prof. Ashley W. Oughterson and Prof. Shields Warren. (National Nuclear Energy Series: Manhattan Project Technical Section. Division 8, Vol. 8.) Pp. xvi+477. (London: McGraw-Hill Publishing Company, Ltd., 1956.) 60*s*.

MILITARY science is advancing apace, and not least in the development of atomic weapons. Military medicine must necessarily keep abreast of the times. It is now more than ten years since the first atomic bombs were detonated over Hiroshima and Nagasaki to conclude the Second World War. These nominal atomic bombs were then about a thousand times more powerful than the current high-explosive bombs. To-day, 'hydrogen' bombs are rated at about one thousand times the power of nominal atomic weapons. This volume, therefore, late though it may appear to be, is a necessary work of reference for everyone in the medical branches of armed forces and civil defence.

The contents have been hitherto available only in a multitude of specialized reports, such as those of the Joint Commission for the Investigation of the Effects of the Atomic Bomb in Japan and its successor, the Atomic Bomb Casualty Commission. This book summarizes the early reports and supplies much of the evidence in a convenient form. Prof. Ashley Oughterson, clinical professor of surgery in the Yale University School of Medicine, was editor-in-chief of the report (in six volumes) of the Joint Commission. Prof. Shields Warren, professor of pathology in the Harvard Medical School, and lately head of the Division of Biology and Medicine of the Atomic Energy Commission, has personally assessed the pathological material.

There are two main features to be stressed. First, "Although the atomic bomb is a finite weapon whose effects can be calculated and partly offset, it has made possible the infliction of stunning casualties at a far lower cost in men, money and materials than ever before". The medical problems raised are therefore not so much technical as administrative—namely, how to cope with tens of thousands of casualties, as at Hiroshima, with virtually all local facilities destroyed. The element of surprise found the Japanese medical administration wanting; but "seventy per cent of the total deaths, in Hiroshima occurred on the first day. At least another 5 to 10 per cent of those who died were so seriously injured that death was unavoidable. . . . It is apparent that if the mortality from atomic bomb explosions is to be effectively reduced, chief reliance must be placed on preventative measures". The second point is that casualties from the secondary effects of blast and from burns presented few novel pathological features. The influence of ionizing radiation on the response to injury was a strikingly new feature, and radiation injury alone was a common cause of death and severe illness. The clinical and pathological features of this syndrome are carefully analysed.

The book is notable for the very large amount of material presented graphically, tabulated or pictorially. There are so many photographs of clinical and histological material that special plates are a rarity, and most of the production is on the very good paper of the ordinary pages. For most of the clinical photographs this is adequate, but many of the photomicrographs are more than usually obscure.

J. F. LOUTIT

## BUILDING: MYTHS AND MAGIC

### Architecture, Nature and Magic

By W. R. Lethaby. With a Biographical Note by Alfred Powell. Pp. 155+15 plates. (London: Gerald Duckworth and Co., Ltd., 1956.) 16*s*. net.

IT was more than fifty years ago when Mr. W. R. Lethaby, who died in 1931, published a little book with the title of "Architecture, Mysticism and Myth". It was true, as the author rather humorously admitted, that there was very little about mysticism in the book; but the title had some substance in it, since it was the first-fruits of a study of what the author considered to be the less understood causes which were so closely connected with the art of building.

Mr. Lethaby believed that ideas of building and architecture generally were intimately allied with other ideas relating to the general structure of the world, and also that man's concept of Nature and his belief in magical properties had a profound influence on the development of ancient architecture. To Mr. Lethaby, man was primarily a builder, and in his architecture he formed a kind of framework for his explanation of the universe. Thus in viewing man's building processes a mere æsthetic appreciation was not enough: it was only by understanding the religious and magical ideas of any particular epoch that the architecture of the period could be fully understood. After "Architecture, Mysticism and Myth" was published, Mr. Lethaby set to work to re-write his thesis in a more comprehensive form. He found, however, that the mass of material on the early history of man, his myths, his magic and his cults, was so voluminous that he finally gave up the attempt; and it was not until 1928 that he re-wrote, with additions, much of his former material and published it in a series of articles in *The Builder* under the title "Architecture, Nature and Magic". These are the articles which are now reprinted in the present more convenient form and they illustrate not only the wide range of Mr. Lethaby's reading but also the power of his imagination and the depth of his understanding.

In the course of his discussion, the author deals with man's idea of the fabric of the world, with special reference to the world tree and the temple of

heaven. He then proceeds to examine these ideas as seen in the architecture of both East and West. Following from these more general considerations, he goes on to consider the more detailed aspects of building, linking up both ornament and style with magical beliefs and the deeper mental processes deriving from the unconscious mind of the master builders. It is here that Mr. Lethaby is at pains to show that modern architecture, when it attempts to copy the past, has lost its soul. To him these sham styles are, as he so graphically puts it, the mere "grimaces of grown-ups". The age of magic has passed: what remains is, to the author of this illuminating book, the mystery of reality, and although mysticism and an outmoded view of the universe have passed away, both mystery and beauty are still left in service and science. If the modern builder is able to achieve a high functional beauty, then he will be able to show in his own architectural creations the same kind of inspired and creative work that Mr. Lethaby has shown to exist in the great buildings and decorative architecture of the ancient world.

E. J. Dingwall

---

## BOTANY OF BRITISH HILLS

### Mountain Flowers

By John Raven and Dr. Max Walters. (The New Naturalist: a Survey of British Natural History.) Pp. xv+240+40 plates. (London: William Collins, Sons and Co., Ltd., 1956.) 25*s*. net.

THE New Naturalist series has proved a potent force in stimulating popular interest in British field natural history during the post-war years, and this latest addition is well in the best tradition of its predecessors—at once informative, authoritative and eminently readable. Already in the series there has appeared a classic concerned with the vegetation of the higher parts of the British Isles in Prof. W. H. Pearsall's "Mountains and Moorlands"; the present volume, as its authors affirm, is scarcely comparable with that of Pearsall as a scientific study, but it is nevertheless in many respects complementary, concerned as it is with the floristic rather than the ecological aspects of the mountain flora.

The book is written in two principal sections: a general one in which the history of the botanical exploration of the British mountains is reviewed and some account given of the nature and history of their flora, and a regional one in which characteristic species of the more important mountain systems of the British Isles are described and discussed. In the appendixes, the authors provide lists of the mountain flora with distribution maps for several species, and keys for the identification of three critical genera with several representatives on the British hills, *Hieracium*, *Alchemilla* and *Salix*.

The chapters concerned with the environment, nature and origins of the British mountain flora in the general section are the work of Dr. Max Walters. He presents the ecological features of montane habitats starkly and in rather general terms; for an appreciation of the subtlety of the interaction of organism and environment in the communities of the hills, the reader would do well to follow his advice and consult other books of the New Naturalist series, notably those of Gordon Manley and of Pearsall. Dealing with the general biology, distributions and origins of mountain plants he is much more at home. Chapter 4 should be particularly informative to naturalists without access to professional journals, containing, as it does, an excellent general account of the trend of contemporary thinking about the history of the mountain species of Britain. Included therein is a survey of the evidence obtained from the investigation of Quaternary peat deposits—evidence which has so convincingly confirmed the view of Edward Forbes, of more than a century ago, that the arctic and alpine elements of the British flora, now mostly restricted to the mountain summits, are essentially the residues of a tundra type of vegetation once widespread, even in the lowlands, during the later stages of the glaciation.

Mr. John Raven contributes the historical introduction, and a number of pleasantly written chapters in the regional section. He is evidently a great lover of rare plants, and one who gains much pleasure from the hunt-the-slipper element so conspicuous in mountain botany. He has a lively sense of the principle of relative rarity—that what matters in extracting the maximum entertainment from plant hunting is not so much how common a plant is in area *A*, but how difficult it is to find at all in area *B*. Perhaps, however, he does not carry the principle far enough, for his disparaging comments on the general poverty of the Irish mountain flora awaken a defensive reaction in at least one of his readers.

Both authors are repeatedly at pains to stress the need for preserving what remain of our mountain plants, and are commendably reticent about localities for rarities. Nevertheless, one is uncomfortably aware of the grim possibility that a book like this, by its very success in popularizing the British mountain flora, may increase the threat to its continued existence if it results in even more profligate collecting. It must be agreed, of course, that a good deal of the damage has been done and is being done by agents other than collectors; even the weights of dried montane herbage in herbaria must be insignificant compared with the tons converted over the years into mutton. But in the present situation where the 'best' mountain plants often survive happily enough in minor oases, inaccessible to sheep and fire although surrounded by burnt and grazed deserts, it is the collector who is their most severe enemy. Furthermore, it is not the indiscriminating tyro who forms the greatest menace to the many mountain species which are distinguished only by their rarity, but rather the type of expert who, in his vanity, imagines that the needs of his particular herbarium or his special research privilege him to ignore the moderation in collecting which he would so severely enjoin upon others.

As one now expects from the New Naturalist volumes, the photographic plates, colour and monochrome, are mostly of a high standard. Some perhaps lack the sparkle that a touch of sunshine would have given, but who would deny that this is appropriate enough in portraits of inhabitants of the British hills. Most of the illustrations are in fact of native individuals. Of the exceptions, it is unfortunately understandable enough why it was necessary to visit the Austrian Alps for a photograph of *Pinguicula alpina*, but it seems a little superfluous to have journeyed so far as North Greenland for a picture of so accessible a British mountain plant as *Silene acaulis*. In the interests of newcomers to mountain botany, some indication of scale might well have been given for the plates.

J. Heslop-Harrison

# THE ROYAL SOCIETY

## ANNIVERSARY ADDRESS* BY SIR CYRIL HINSHELWOOD, F.R.S.

ANOTHER year of intensive preparation reached its climax on November 13 when H.M. the Queen visited the *Magga Dan*, which was to convey the Royal Society expedition to the Antarctic, and when the members of the expedition were presented to her. The ship sailed two days later bearing the good wishes of all, on this combination of physical and scientific adventure which will make an important contribution to the International Geophysical Year. A great debt is owing to all who took part in the arrangements and especially to Sir David Brunt and to Dr. D. C. Martin, who have borne so much of the burden and heat of the day.

When he has completed a year of office, the President cannot but be very conscious of all that he himself owes to the other officers and to the staff at Burlington House. As the activities of the Society increase this becomes more and more one of the major things which need to be emphasized in this address. I must speak specially of the retiring Treasurer, Sir Thomas Merton, who is handing on his great responsibilities after seventeen years of unique service in that office. Sir Thomas took control of the Society's finances at a moment when they were beset by difficulties of all kinds. By a whole series of wise reorganizations, by a brilliant policy of reinvestment and by unremitting vigilance, he not only weathered the storm but has left the financial position of the Society stronger than it has ever been. Sir Thomas not only carries with him our grateful appreciation for what he has done, but also the assurance of an honoured place in the history of the Royal Society.

## AWARD OF MEDALS, 1956

### Copley Medal : Prof. P. M. S. Blackett, F.R.S.

Prof. Blackett has made important contributions to three main fields of physical discovery : the interaction with matter of fast particles from radioactive sources, the nature of the particles in the cosmic rays, and the magnetism of the Earth. In each of these he has combined outstanding insight and skill with novel developments in instrumentation.

During 1921–31 he was chiefly occupied with the development and operation of automatic Wilson cloud chambers and their application to the precise measurement of the parameters involved in collisions between α-particles and atomic nuclei. He showed that very infrequent inelastic collisions with nitrogen produced the then unknown isotope $^{17}O$ by the capture of the α-particle and the ejection of a proton.

In this period also he verified, with Champion, the Mott theory of the wave-mechanical diffraction scattering of slow α-particles.

From 1931 onwards he applied and extended the cloud-chamber technique to the study of the collisions involved in the cosmic rays, establishing (with Occhialini) the existence of nearly equal numbers of positive and negative electrons. This confirmed Anderson's discovery of the positive electron a few months before and extended it by giving strong evidence for actual pair production. The 0·5 MeV. scattered γ-rays were recognized by him to arise from the annihilation of positive and negative electron pairs.

Blackett proceeded to study in more detail the nature and the energy spectrum of cosmic-ray particles. Much valuable work on cosmic-ray showers was carried out under his direction, and he himself explained the negative temperature coefficient of the cosmic rays in terms of the decay of the μ-meson.

These detailed studies led to a discovery which opened up a new field when Rochester and Butler in Blackett's Manchester laboratory in 1946 found the first neutral $V$-particles and in 1947 the first charged $V$-particles. The identification by the Manchester team of $V^0$ decay into a proton and a pion and of the probable division of a $V^1$ particle into two pions, together with the best determination to date of the life-times of $V^0$ and $V^1$ neutral particles, are outstanding further discoveries. These were made possible by Blackett's energetic action in moving the equipment to the observatory of the Pic du Midi.

From 1947 onwards he interested himself in the possibility, originally discussed by Schuster, of a 'fundamental' connexion between the angular momentum of a large rotating body, such as the Earth, and its magnetic field. Although experiments conducted and directed by him gave no support to this idea, the sensitive magnetometer designed by Blackett for this work has been used by him and by Runcorn at Cambridge with success in remarkable studies of palæomagnetism and the light it can throw on polar wandering and continental drift.

Throughout his career Blackett has shown great ability and drive in organizing team effort in difficult fields of research. The building up of the Jodrell Bank radioastronomical station by Lovell owes much to him. He was awarded a Royal Medal in 1940 and the Nobel Prize for Physics in 1948.

### Rumford Medal : Dr. F. P. Bowden, C.B.E., F.R.S.

Dr. Bowden is recognized as a leading research worker on the properties of solid surfaces. His early work was on the mechanism of the electrodeposition of ions at metal surfaces. He then turned his attention to the nature of the contact between solid surfaces and the mechanism of friction. He showed that however carefully surfaces are prepared they are generally covered with asperities large compared with atomic dimensions. When such surfaces are placed together, they touch at the tips of these asperities, which are crushed down until they are large enough to support the applied load. The area of real contact is thus independent of the size of the bodies and is proportional to the applied load ; it is usually only a minute fraction of the geometric size of the bodies. At the regions of real contact strong adhesion occurs. The resulting friction arises from the shearing of the

* Delivered at the Royal Society on November 30.

welded junctions formed at these points and to a lesser extent from the ploughing of one metal through the other.

Bowden has shown that because the area of true contact is so small, the work done in overcoming friction can raise the temperature of the local contact points to extremely high values. Ingenious methods for measuring this temperature were developed, and it was shown that in many cases surface melting may be produced which plays a fundamental part in processes such as polishing and the surface flow of solids. With modern physical methods he has studied the effect of surface films and in particular of boundary lubricants on the interaction between solid surfaces. This work forms the background to the modern theory of friction and boundary lubrication. The practical implications of the work are widely appreciated, and it has led to the development of new low-friction surfaces, improved bearing materials and to the development of special lubricants.

Another phase of Bowden's work is the study of fast reactions in solids and the initiation and growth of explosion in crystals. This has led to a clearer understanding of the cause of accidental explosions and improved methods of manufacturing and handling explosive substances.

## Royal Medal (A) : Dr. Dorothy M. C. Hodgkin, F.R.S.

Dr. Dorothy Hodgkin has made many outstanding contributions to our knowledge of the structure of complex organic molecules by the method of X-ray crystal analysis. Her best-known work is perhaps that on the structure of penicillin, and more recently her complete elucidation of the structure of vitamin $B_{12}$. In this work she has shown that it is possible to apply the methods of X-ray analysis to elucidate structures of molecules which are too complex to yield to the ordinary methods of chemistry.

With Bernal she obtained the first X-ray pattern from a protein single crystal (pepsin) in 1934, and from insulin in 1935. Later, with Schmidt, she made the first X-ray study of a virus single crystal (tobacco necrosis virus). With Bernal and Fankuchen she has completed a most comprehensive study of the crystallography of more than eighty sterol derivatives, belonging mainly to the cholesterol and ergosterol series.

It is perhaps in the field of complete structure determinations that her most important work has been done. She was among the first to realize the importance of the heavy-atom phase-determining methods, and these she used to effect the first complete determination of the geometry of a sterol derivative in her analysis of cholesteryl iodide. This was followed later by a similar analysis of a calciferol derivative and of a lumisterol derivative.

The same powerful phase-determining methods of analysis, and in particular her gift of being able to interpret correctly the complex and partially resolved electron-density patterns obtained, have been mainly responsible for her success in finally elucidating the structure of penicillin and of vitamin $B_{12}$. This last work is the most beautiful and complex analysis which has yet been achieved in this field.

## Royal Medal (B) : Dr. O. T. Jones, F.R.S.

Dr. Jones is widely recognized as the most versatile of living British geologists, being equally at home when dealing with stratigraphical, structural, palæontological or petrological problems.

It was he who first worked out in detail the succession of graptolitic sediments in central Wales, thereby bringing order into a vast area which had formerly been quite wrongly interpreted. More recently, with Pugh, he has, by detailed large-scale mapping, in the Builth area, revealed an example of an ancient Ordovician shore-line, with cliffs and beach deposits, thereby proving that large-scale elevation, erosion and deposition of many hundreds of feet of sediments can fall into the time represented by a single fossil zone, which elsewhere is indicated by only a few feet of sediments.

His work has thrown an entirely new light on the origin of certain complex structures in the sediments of the Lower Palæozoic rocks of north Wales. This study of 'slump structures' enabled him not only to point to the origin of the structures themselves, but also led him to use the detailed patterns in the sediments to interpret the general arrangement of land and sea during the time of their formation. The results of this study have revolutionized the views concerning the growth of the Welsh Palæozoic geosyncline.

In recent years he has published the results of a life-long study of the plateau surfaces of the Welsh mountain areas and traced their origin far back into geological time, thereby giving a firm foundation to the theories advanced by others concerning the river systems of Wales and the West Country.

His best-known work centres on his native Wales, but much of it also deals with more general topics, and of recent years he has taken much interest in the geological interpretation of geophysical results, where his wide knowledge of structural geology has enabled him to assess the value of the interpretation made by the geophysicists.

Wherever his researches have taken him, he has broken new ground and led the way to new lines of research.

## Davy Medal : Prof. R. D. Haworth, F.R.S.

Prof. Haworth, over a period of some thirty-five years, has made outstanding contributions to the chemistry of natural products, particularly the alkaloids.

His first important work was on the isoquinoline synthesis of alkaloids in the aporphine, berberine and related groups. Later he extended his synthetic work on the aporphine group of alkaloids and in particular synthesized morphothebaine methyl ether, which was a connecting link between the thebaine and morphine groups of alkaloids.

In association with G. R. Clemo, he successfully synthesized a number of degradation products of santonin, and then with various pupils, particularly at Sheffield, he studied many natural pigmented compounds of high molecular complexity, notably retene and the phenolic resins which constitute the lignan group of natural products. Purpurogallin yielded up the secrets of its structure to him and he was able to synthesize this interesting compound in 1949. His discovery that it contained a tropolone ring led him to engage in tropolone chemistry, in which field he has made significant contributions, particularly to the study of novel substitution reactions. He has conducted valuable researches in the complex steroidal group of alkaloids, especially on conessine, he has investigated the fundamentals

of the reaction of formaldehyde with proteins, and he has carried out numerous synthetic studies on a variety of complex nitrogen-containing natural compounds.

### Darwin Medal : Dr. J. S. Huxley, F.R.S.

Dr. Julian Huxley has left his mark in a number of varied fields of biological science. His concept of the cline proved of such value in the description and understanding of geographical variation, in both its genetical and ecological aspects, that it passed almost immediately into very wide use. He was one of the pioneer students of courtship behaviour in birds; indeed, in his classical paper on the great crested grebe he gave the first descriptive analysis of mutual display and introduced the notion of mutual selection. He has contributed to the evolutionary study of behaviour and to the theory of sexual selection. He has given us the idea of allæsthetic selection and has defined allometry or heterogonic growth as it is variously called. His investigations of heterogonic growth in a variety of animals brought to light the existence of allometric gradient fields, the evolutionary implications of which he pointed out. His early genetical investigations of *Gammarus* led him to appreciate the evolutionary significance of rate genes, and he has recently discussed the significance of polymorphism, or morphism as he prefers to call it.

Yet to many his greatest work will have been the part he has played in the development of the neo-Darwinian theory of evolution, of which he was indeed one of the earliest exponents. He is one of a number of biologists who have contributed in their various ways to this development, by experiment, mathematical analysis and theoretical discussion. Huxley has a place all to himself in that his wide interests, encyclopædic knowledge, and ability to see the connexion between widely separate fields, have enabled him to bring together and bind into a single evolutionary thesis the findings of the most diverse branches of biology. He has been one of the leaders in the rise of modern evolutionary biology, and a never-failing stimulus to those who have come into contact with him in this field.

### Hughes Medal : Viscount Cherwell, P.C., C.H., F.R.S.

Lord Cherwell's earliest papers are mainly connected with specific heats at low temperatures, but include many contributions on such varied items as radiation pressure applied to cosmic problems, the transmission of X-rays and the structure of atoms and nuclei, including an approximate quantitative theory of the Geiger–Nuttall relation. His work on the solid state led to the well-known melting-point formula. In this connexion he began to take an interest in the photoelectric effect, connecting the frequency of the selective effect in the alkali metals with the characteristic frequencies, the latter being calculated either from the melting-point formula or by 'Rest-Strahlen' determinations.

During the First World War he worked at the Royal Aircraft Establishment. There he learnt to fly, and his main interests were concerned with the instruments of flight and with the problems of flight itself. He produced many technical papers in a wide range of subjects, including those on the theory of compasses, on the collision of aircraft with balloon-barrage cables, and on the conditions which caused vertical spin in aircraft in flight and the methods of extraction of the machine from spin when involved either accidentally or deliberately in such a manœuvre.

After the War he devoted himself in Oxford to the reorganization of an obsolescent department into the important laboratory it is to-day. Perhaps his most important direct contribution to physics was his pioneer work with Prof. G. M. B. Dobson on meteors, which led by means of calculations of the height, frequency and the temperatures of the trails to a considerable increase in our knowledge of temperature distribution in the upper atmosphere, particularly the increase in temperature above the stratosphere. The latter was satisfactorily explained by the absorption of radiation by a layer of ozone. Further work was done on photoelectricity, mainly in connexion with its application to the determination of temperature, both in stars and in terrestrial sources, work which included the design of the well-known Lindemann electrometer. He has always been interested in astrophysics and cosmic phenomena, and has written many notes on these subjects. In particular, he has suggested the origin of magnetic storms as due to the recombination of electrons and ions in the upper atmosphere which arise from ionized clouds of gas ejected from the Sun, the velocity of the particles in the cloud being ascribed to light pressure.

In the Second World War he acted as scientific adviser to Sir Winston Churchill and produced a large number of reports and appreciations, many of which are mentioned in Churchill's book "The Second World War".

---

## SOME INTERACTIONS OF THE PHYSICAL AND THE BIOLOGICAL SCIENCES

The citations which have just been read leave no anxiety about the importance of the contribution which Fellows of the Royal Society make to the improvement of natural knowledge. In hearing them we may perhaps feel that passing regret which we experience on a journey when some fascinating vista opens at a new turn of the route, and we are moved by the desire to explore it while realizing that we never shall. We are swept onward about our own business.

People often think nostalgically of the early days of this Society when all the Fellows could understand everything that went on. Range and diversity were, however, available at the price of superficiality and incoherence when even Newton seems to have felt that his view of Nature consisted after all of a series of very imperfectly related parts. To-day the whole has more structural unity, yet often seems so vast and labyrinthine that we get lost if we venture beyond our own small locality, which itself reveals subtleties and complexities multiplying almost without limit the more closely we look.

The process of elaboration, though deplored in one quarter or another almost daily, is not quite irreversible. As in all the great movements of Nature or of humanity, there are opposing tendencies and compensating reactions. On one aspect of this matter I shall dwell a little now.

At one time the segregation of the physical and the biological sciences could scarcely have been more complete. It is reflected indeed in the dichotomy of the Royal Society itself. The lines of demarcation are gradually vanishing, and our duplex structure is becoming something of an anachronism.

The fusion is occurring in many places: the interpretations of nerve action in terms of ionic flow, and of cortical events in terms of spatio-temporal patterns of neuronal activity; the analogies between the working of the brain and the operations of electronic calculators; all these and many more have for a long time compelled the simultaneous study of widely different fields of science.

It is difficult to think oneself back to the time when the preparation of urea from ammonium cyanate caused something of a sensation in the world. In his "Essays on Historical Chemistry" Thorpe wrote: "That particular day in 1828 when Wöhler first observed the transformation of ammonium cyanate into urea should be accounted a red letter day in the history of science".

Things have moved since then; structures have been determined and syntheses achieved for every kind of vital product from the anthocyanins of flowers to the adenosine triphosphate which so subtly regulates the energy exchanges in the cell. A year or two back the pituitary hormone oxytocin was synthesized by du Vigneaud and his collaborators, and the synthesis of another peptide pituitary hormone has been announced this year. Steroids are the object of unremitting and successful work in several laboratories, and nucleotide coenzymes continue to yield to the investigators of Todd's school, the total synthesis of cozymase having recently been carried out.

The relation of molecular structure to properties is a major chapter of science and now forms a body of doctrine built up over a century. Through the stimulus, partly industrial, of the intensive work on polymers—those huge molecules now made almost to a predetermined specification of properties—this study to-day embraces some of the chief constituents of the living cell.

Natural compounds of very high molecular weight, formed at low temperature and under the directing influence of existing cell structures, have normally a much more regular configuration than the chains randomly formed in polymerizations initiated by free radicals at high temperatures. The gap between the natural and the artificial has been significantly narrowed by the recent discoveries of Ziegler and of Natta. By the use of new catalysts based upon aluminium alkyls and titanium or vanadium chlorides, beautifully oriented polymers of regularly repeating structures are formed. The initiation mechanisms may well be ionic, and the regularity is almost certainly due to the guiding influence of a heterogeneous catalyst.

The closer approach of this mechanism to that used in the cell is very suggestive. Substances closely resembling natural rubber and guttapercha (which stand in a *cis-trans* relation to one another) have indeed been made by such means. The properties of these regularly ordered polymers are profoundly different from those of the less ordered forms, and during this year Natta, Corradini and Dall'Asta, in a study of crystalline polypropylene oxide, comment on the notable analogies between their product and the fibroin of silk.

In this general connexion the recent work of Ballard and Bamford is highly suggestive. These authors find that in the polymerization of DL-phenylalanine-N-carboxy α-amino-acid anhydride initiated by polysarcosine dimethylamide, the polysarcosine chain is able to catalyse the reaction between the base and the anhydride in a marked degree. They justly point out the analogy between this phenomenon and an enzyme reaction.

Work continues in many laboratories on the fibrous and globular proteins and on nucleic acids (and models have recently been shown to the Royal Society of the beautiful structures which the X-ray crystallographers are beginning to propose for these vitally important substances).

The problem is enormously complicated, but its attraction depends, of course, largely upon the belief, widely held on good grounds, that these structures are fundamentally concerned in the processes of heredity. Nevertheless, the view that nucleoproteins are the basis of genes which could ever be self-replicating in isolation and merely in virtue of their structure is probably a dangerous over-simplification.

In the chemistry of inanimate Nature the study of structure alone is quite insufficient and must be undertaken in conjunction with that of function; in other words, reaction mechanisms are as important as molecular structures.

That the properties of living things are an emergent result of contributions from finite, if large, numbers of structural units or genes, that the genes are rather stable though not immutable, that in proper circumstances they change their associations in accordance with the laws of probability, are among the major basic principles of science. Recent work has, however, widened the view of the ways in which hereditary characters are transmitted. Besides sexual unions there are transmission by infective agents, by transduction and by Pontecorvo's parasexual mechanisms. Moreover, the combinatory phenomena that are so important in the Mendelian system cannot play much part in micro-organisms which multiply by binary fission. Fruitful as the reference of cell properties to the structure of genes has been, the body of doctrine which rests on this assumption is in some important respects incomplete, as indeed every chapter of science must be incomplete by itself. The picture presented is essentially static. The phenomena of growth, adaptation and reproduction need a dynamic one.

No one structure is likely to be autosynthetic in isolation; even the viruses require as hosts more or less intact cells, the machinery of which they can exploit. The building blocks of the cell, wonderful though they may be as structures, are useless by themselves. Cell function depends upon the rhythm and harmony of their reciprocal actions: the mutual dependence of protein and nucleic acid; the spatial and temporal relations of a host of elementary processes which with their sequences and bifurcations make up the reaction pattern of the cell. A system of mutually dependent parts, each of which performs something like enzymatic functions in relation to another, will, as can easily be shown, in the steady state appear as a whole to be autosynthetic. No individual part need be credited with a new and mysterious virtue by which to duplicate itself. Thus the picture widens beyond the structural units to their quantitative proportions, to their reciprocal dependence and to their rates of growth. This fusion of physical chemistry and biology leads to conclusions about the nature of adaptive processes, the automatic attainment of maximum growth-rates, and mechanisms for the choice of the most favourable metabolic patterns (as in the Pasteur effect).

The reality of the dynamic picture is sometimes called in question because there may be alternative explanations of particular phenomena. For example, the important phenomenon whereby drug resistance

develops is often referred exclusively to selection of random mutants, although it is easy to show on the basis of very general physico-chemical assumptions that the effect should demonstrably occur as an automatic response, the adapted cells having reorganized their reaction patterns. This conclusion in its turn in no way denies the possibility of spontaneous resistance due to structural mutations. Nor, on the other hand, does the occasional demonstration of mutations leading to resistance rule out automatic cytoplasmic adjustments.

One possible prescription for steering between the opposite hazards of narrowness and of superficiality is to try to set the particular objects of one's own interest into a general framework, working with a large map but filling in small areas with as much detail and accuracy as possible. Partly on this principle, but also, I confess, a little to vindicate my feeling that a president of this Society, whatever his other preoccupations, has the right and duty to remain a working man of science, I am proposing to devote a few paragraphs to some matters, relevant to the general theme, but closely connected with one of the fields of my own activity.

Resistance to the idea that some biochemical adaptations of cells are due to automatic internal reorganization has been largely founded on the relative stability of such changes, and upon the doctrine that heredity only changes by spontaneous gene mutation. Evidence, however, accumulates that adaptive processes are indeed reversible. *Aerobacter aerogenes*, once it has acquired the power of utilizing D-arabinose ($A^+$ character), holds it for a long time, but some strains of *Escherichia coli* revert rather quickly. Cross found that with *Aerobacter* loss of the $A^+$ character occurred more rapidly in certain media which themselves imposed a new adaptive necessity on the cells. The effect might have been attributed to a re-selection in these media of a small residual contamination of $A^-$ (or of reverse mutants); but this explanation was ruled out by comparative experiments with artificial mixtures of the $A^+$ and $A^-$ types. The real reversion of the population in conditions not favouring the selection of the $A^-$ cells showed that arguments based upon the assumed permanence of the change are inadmissible.

The impression that drug resistance is a necessarily stable character is weakened still further by the study of micro-organisms other than bacteria. Wild found that with strains of *Saccharomyces cerevisiae* the degree of persistence of adaptation to various inhibitors is very variable.

Other evidence bearing on the nature of the adaptive changes responsible for drug resistance comes from the detailed study of time–number relations in colony formation on agar plates containing an inhibitory substance. If, say, $10^8$ cells are plated on a solid medium containing a drug at a suitable concentration, there may appear 10–100 well-developed colonies which have been widely regarded as spontaneous mutants. But if the statistical distribution of the times at which they appear is compared with that for a correspondingly small number of cells previously adapted to resist the drug, then the comparison shows that the few survivors from the unadapted strain have formed colonies much more slowly than the members of the adapted strain. Individuals of this latter could therefore not have been present in the original even in the minute numbers supposed. Results of this kind have been found by Wild with yeast and by Dean with some bacterial strains. In some of these examples, moreover, the non-existence of minute numbers of the adapted forms in the original population is demonstrable even when the standard of resistance studied is quite a low one. Thus alternative explanations based upon complex series of multiple mutations would be forced to include highly unlikely assumptions.

One method by which pre-existent mutants are often tested for may be illustrated in the example of the well-known *Bacterium coli mutabile*. This organism normally refuses to grow on a lactose-agar plate except after a long delay. If, however, a very large inoculum of cells of the order $10^8$ or $10^9$ is plated, some colonies develop much more rapidly, and their number has been used to give a measure of the mutation-rate to the so-called lactose-positive condition.

Dean undertook a study of the statistics of colony formation by this organism on lactose-agar plates, measuring the distribution of colony sizes at various times, and the distribution of the times required for the formation of colonies of various standard sizes. The results conformed rather closely to Gaussian distributions, and the relatively few early-forming large colonies which might have been labelled lactose-positive mutants did not seem to be more frequent than the Gaussian law could permit in so enormous a population.

All these observations support the view that the cell makes adaptive changes by dynamical adjustments as well as by any mutations which it may suffer.

Normally, mutations, apart from those caused by radiation or special chemical agents, have been supposed to occur only when cells divide. This view itself seems to be changing.

Some years ago, Baskett made a number of observations individually and collectively indicating that during the long delay which attends the first growth of *Bact. lactis aerogenes* on D-arabinose there is in fact a physiological adaptation of the cytoplasm, and not the selection of mutants. Generally similar results have been found by Dean for cells initially reluctant to use lactose.

Somewhat analogous observations in a more spectacular form were reported by Akiba, and more fully by Szybalski. Bacterial strains exposed to streptomycin for a number of days in a buffer not supporting growth were found eventually, if they had survived at all, to have become resistant to the antibiotic. Szybalski, however, quotes what he calls "tentative evidence" that the changes occur in a nucleus. This evidence is derived from observations on the crossing or transduction phenomena which occur with certain strains of *Escherichia coli* and *Salmonella*.

The conclusion, however, seems to be far from certain, since the relations found in crossing drug-resistant with sensitive organisms are usually very complex. In genetic analysis with micro-organisms the number of parameters which can be adjusted is considerable, and illusory effects of sharp segregation phenomena are sometimes produced by the process of dividing continuous variables such as rate or time of growth into arbitrary domains such as 'slow' and 'fast' or 'plus' and 'minus'. That a high percentage of non-dividing cells should suffer nuclear mutations making them resistant precisely to that drug to which they are being exposed seems much harder to explain than the alternative of a dynamical change

by which the cell as a whole reacts to the presence of the drug in an almost predictable way. The same general comments might be made about the 'spontaneous mutations' in the absence of division, to histidine-independence of a bacterial strain recently studied by Ryan.

In spite of some alarm, physico-chemical mechanisms of cell adjustment need not be in any conflict at all with valid principles of genetics. But it is a misapplication of the latter when they are used to exclude all mechanisms except selection of random mutants or of favourable gene combinations. Random mutations to drug resistance may indeed be shown by the relatively rare examples where the Lederberg technique of replica plating has given positive results. Nature, however, presents us with a vast hierarchy of systems: sub-atomic units (in a vast and confusing array), atoms and molecules, micelles, chromosomes, nuclei, cells, colonies, tissues, individuals and communities of individuals. Nobody can suppose that all phenomena have their origin at any one particular level.

In the organisms studied by classical genetics, individuals develop from fertilized germ cells, and, not surprisingly, show characteristics largely inherent in those cells. In micro-organisms which multiply by binary fission, the new individual does not develop from a much smaller germ cell but is formed by the approximate halving of an existing one, and, no more surprisingly, shows the characteristics of this. The manifestation of the effects of genes has long been recognized to be profoundly affected by their environment, so that the subsequent growth of the divided daughter cells is largely governed by the total organization. This explains—and more specific physico-chemical illustrations can be given—why such characters as drug resistance due to enzymatic reorganization can persist through many divisions. But to call the phenomenon or its interpretation Lamarckian is a plain misuse of language.

The disentangling of the complicated and fascinating relationships met with in this field will demand close co-operation of the physical and biological sciences, which brings me back to the keynote of this address. To the highly ingenious models of structure must be added equally illuminating models of function. Whatever the answer may be to the controversial problems of to-day, that is what the future in one way or another will surely bring forth.

---

# OBITUARIES

## Prof. Winifred Cullis, C.B.E.

By the death on November 13 of Prof. Winifred Cullis the world has lost not only a fine scientist but also an outstanding personality.

Winifred Clara Cullis was born in Gloucester on June 2, 1875. King Edward VI's High School for Girls, Birmingham, and Newnham College, Cambridge, laid the foundation of her abiding interest in science and began many life-long friendships. In 1901 she was appointed demonstrator in physiology at the London (Royal Free Hospital) School of Medicine for Women; later she became lecturer, reader and head of the Department, and finally professor of physiology in the University of London. She retired during the Second World War.

From the beginning, research was Prof. Cullis's great interest, and her name will always be associated with two outstanding pieces of work, one on the mechanism of the secretion of urine and the other on the perfused isolated heart of rabbit. Her experimental technique was precise and careful, and it was a joy to see the delicacy and sureness with which she would snip sufficient of the auriculo-ventricular bundle in the beating heart in order to demonstrate the effects of partial heart block. In later years lectures at home and abroad made continued research work more difficult; but periodically she would give herself a 'holiday' and with one or more colleagues settle down for several weeks investigating some interesting problem. She gave unstintingly of her knowledge and wide experience to her departmental colleagues but always insisted that publications should be in their own names, and any appreciation of their work gave her great pleasure.

No one who knew her could be other than filled with admiration for the absolute integrity and shining honesty which characterized her scientific outlook and the public work which later claimed so much of her time. For self-seeking, pomposity or hidden motives she had no use, and nothing was more direct than her own approach to a problem.

This directness, together with her gaiety and wit, made her lectures and speeches unforgettable. She had a store of appropriate stories—often against herself—and it was seldom that a speech of hers was not punctuated by laughter.

She herself realized how valuable were her special gifts as a speaker, and she gladly spoke for any cause she had at heart, particularly where she felt she could assist in securing for professional women equal opportunity and status with men. Her great charm was to a large extent due to her intense interest in and understanding of her fellow men and women. This and her generous appreciation of the other person's point of view, even when she disagreed, was particularly valuable in international contacts. In her work for the British Federation of University Women and for the International Federation of University Women, in each of which organizations she held the presidency for a number of years, she combined her interest in the advancement of women and her belief in the great value of international understanding and good will

Of the many honours and marks of appreciation that came her way, few gave Prof. Cullis greater pleasure than the decision of the British–American Associates to name one of their lecture fellowships after her.

She felt strongly that physiology should be taught in the schools and gave a series of most successful talks in the B.B.C. Schools Programme. She wrote two excellent books on the subject for use in schools. "Your Body and the Way it Works", published in 1949, is a very clever blending of her text with pictures by Ian T. Morison. Included is a section on growth, reproduction and heredity which is an aspect of human biology normally omitted from elementary books.

Few women could have had so many friends. She collected them from a world-wide circle. Her memory for them was amazing, and she would call to mind details about people she had not met for years and with whom she could have had the briefest conversation.

The loss of Winifred Cullis leaves a void in the lives of those who knew her, not only because she was a unique personality but also because of the deep affection she inspired. M. BOND

## Dr. A. L. Clark

IT was with a sense of genuine sorrow that the many friends of Dr. Arthur Lewis Clark learned of his death on September 20 at Kingston, Ontario, at the age of eighty-three.

Dean of the Faculty of Applied Science at Queen's University, Ontario, for twenty-four years from 1919, an outstanding physicist in research, Dr. Clark had retired in 1943, but continued to lead a full and active life until a short illness before his death. Dr. Clark was born on February 19, 1873, at Worcester, Mass., where he was educated, going to the Polytechnic Institute, where he obtained his B.Sc. degree. After doing his graduate work and some teaching, he went to Queen's University in 1906 as head of the Physics Department.

Dr. Clark's scientific interest was in thermodynamics and he carried out considerable research in this field. In 1916 he was appointed chairman of the University Scientific Research Committee. His recommendations with regard to the support of research at that time were far-reaching and established standards worthy of acceptance by any university to-day. In 1919 Dr. Clark was appointed dean of the Faculty of Applied Science, a post which he held until his retirement in 1943.

Retirement did not mean idleness to Dr. Clark, for one of the first tasks he set his hand to was writing his own now famous Queen's document, his book "The First Fifty Years", a history of the Science Faculty of Queen's from 1893 until 1943. The book filled a blank in the University records and has been enthusiastically received by graduates of all faculties.

During these twenty-four years there was war and depression, bringing great stress and strain to the University. Nevertheless, under Dean Clark's wise and efficient guidance, the standards of work in the various branches of engineering were more than maintained and the School of Applied Science grew to maturity. Dean Clark's firmness, tempered with patience and sympathy, won the esteem of staff, graduates and students alike.

In compiling the above note, I am indebted to Mr. David G. Dewar for information from his book, "Queen's Profiles", published by the office of Endowment and Public Relations, Queen's University.

H. G. CONN

# NEWS and VIEWS

## International Meteorological Organization Prize : Dr. H. T. Hesselberg

DR. HANS THEODOR HESSELBERG, formerly director of the Norwegian Meteorological Institute and president of the International Meteorological Organization, has been awarded the International Meteorological Organization Prize. This Prize was created by the World Meteorological Organization to perpetuate the memory of the non-governmental international organization which that specialized agency of the United Nations has succeeded. It is to be presented once a year in recognition of scientific contributions to meteorology and work for international meteorological organizations. Dr. Hesselberg, who has received the first award, was born at Lierne in Norway in 1885, and has devoted himself from 1912 onwards to meteorological and hydrological research. As scientific assistant to Dr. Bjerknes, he participated in research in the fields of dynamic meteorology and hydrology. He was director of the Norwegian Meteorological Institute during 1915–55. During these forty years he was mainly concerned with the organization of the Meteorological Service of Norway and international co-operation. From 1919, he took an active part in the work of the International Meteorological Organization, of which he was president during 1935–46. Dr. Hesselberg was a member of the executive committee of the World Meteorological Organization during 1951–55.

## Mathematics in the University College of North Staffordshire : Prof. D. S. Jones, M.B.E.

MR. DOUGLAS JONES, who has been appointed to the chair of mathematics in the University College of North Staffordshire in succession to Prof. I. N. Sneddon (see *Nature*, 177, 1109 ; 1956), was educated at Wolverhampton Grammar School, and went up to Corpus Christi College, Oxford, with an open scholarship in 1940. Soon afterwards, however, he joined the R.A.F., becoming attached to night fighters as a signals radar officer. In 1942 he was put in charge of a special research unit, and for his work in this capacity was mentioned in dispatches and later made M.B.E. In 1945 he returned to Oxford, where he took first-class honours in mathematics two years later. Then he went with a Commonwealth Fund fellowship to the Massachusetts Institute of Technology, where he started his researches on wave diffraction theory. This has continued to be his major research interest ; but the power and complexity of the mathematical methods he has brought to bear on it have never been allowed to obscure in Jones's mind, nurtured alongside the pressing needs of war-time radar, the many practical applications of the results of his calculations. In 1948 he returned to England as an assistant lecturer in the Mathematics Department in the University of Manchester, where he was promoted to lecturer in 1951 and to senior lecturer in 1955. He has held the responsible position of tutor to the Faculty of Science since 1954, and while on leave of absence for six months in 1955 was a visiting research professor at the Institute of Mathematical Sciences, New York University. His most recent interest is a fundamental study of methods for calculating short-wave scattering.

## British Cotton Industry Research Association : Dr. G. F. Davidson

DR. G. F. DAVIDSON, of the British Cotton Industry Research Association, head of the Chemistry Department at the Shirley Institute, Manchester, is resigning

his post at the end of this year, though he will remain in the service of the Association. Dr. Davidson has already served for thirty-four years on the scientific staff of the Association. Much of this time was occupied by studies of the chemistry of cotton cellulose, and his contributions to this subject are widely recognized. At the beginning of his investigations, the modern concepts and theory of cellulose structure were only just emerging. He used the new concepts to correlate a large body of otherwise confusing experimental observations. In doing so, he helped to establish the theory; and, in seeking a theoretical explanation of certain practically important observations, he uncovered fresh facts stimulating theoretical investigations in a more general field.

### Dr. J. Honeyman

Dr. J. Honeyman, lecturer in organic chemistry at King's College, University of London, has been appointed to succeed Dr. Davidson at the Shirley Institute. Dr. Honeyman's work has also been mainly in the field of carbohydrate chemistry. He graduated from the University of St. Andrews in 1939 and obtained his Ph.D. from that University in 1944. After spending a number of years in industry, Dr. Honeyman was appointed assistant lecturer at King's College, London, in 1945, and lecturer in 1947. He has contributed many papers, chiefly concerned with carbohydrates, and in 1948 published an "Introduction to the Chemistry of the Carbohydrates", of which a revised edition was published in 1951. During 1954–55 Dr. Honeyman held the post of Hibbert Fellow at McGill University, and was visiting scientist at the Pulp and Paper Research Institute of Canada.

### Royal Society: Officers and Council

At the anniversary meeting of the Royal Society held on November 30, Sir Cyril Hinshelwood was re-elected president. Sir William Penney, director of the Atomic Weapons Research Establishment, Aldermaston, was elected treasurer in succession to Sir Thomas Merton. The other officers re-elected for the ensuing year were: Physical Secretary, Sir David Brunt, chairman of the Electricity Supply Research Council of the Central Electricity Authority; Biological Secretary, Prof. G. L. Brown, Jodrell professor of physiology at University College, London; and Foreign Secretary, Dr. H. G. Thornton, head of the Department of Soil Microbiology at Rothamsted Experimental Station. Other members of the Council elected were: Prof. C. E. H. Bawn, professor of inorganic and physical chemistry, University of Liverpool; Prof. T. A. Bennet-Clark, professor of botany, University of London (King's College); Brigadier J. S. K. Boyd, lately director of the Wellcome Laboratories of Tropical Medicine; Dr. Mary L. Cartwright, mistress of Girton College and university lecturer in mathematics, Cambridge; Prof. N. Feather, professor of natural philosophy, University of Edinburgh; Sir Claude Gibb, chairman and managing director of Messrs. C. A. Parsons and Co., Ltd.; Sir Bryan Matthews, professor of physiology, University of Cambridge; Prof. J. S. Mitchell, professor of radiotherapeutics, University of Cambridge, and director, Radiotherapeutic Centre, Addenbrooke's Hospital, Cambridge; Prof. W. T. J. Morgan, deputy director of the Lister Institute and professor of biochemistry, University of London; Prof. N. F. Mott, Cavendish professor of experimental physics, University of Cambridge; Prof. L. Rosenhead, professor of applied mathematics, University of Liverpool; Dr. B. F. J. Schonland, deputy director, Atomic Energy Research Establishment; Dr. K. M. Smith, director of the Virus Research Unit (Agricultural Research Council), Molteno Institute, University of Cambridge; Prof. M. Stacey, professor of chemistry, University of Birmingham; Dr. W. H. Thorpe, university lecturer in entomology, Cambridge; Prof. L. R. Wager, professor of geology, University of Oxford.

### *International Journal of Applied Radiation and Isotopes*

The new periodical, the *International Journal of Applied Radiation and Isotopes*, published by Pergamon Press (London and New York), is to provide a medium for the publication and discussion of radioactive and radiation techniques and the applications of radioactive isotopes and large fluxes of radiation in the pure and applied sciences, medicine, agriculture and industry. The subscription is £6 (17 dollars) or, for individual subscribers certifying that the journal is for their private use, £3 10*s.* (9.80 dollars). The list of nine editors, headed by P. C. Aebersold (Oak Ridge, U.S.A.), which includes eminent scientists from France, Holland, Great Britain, the Netherlands and the U.S.S.R., and the editorial advisory board which consists of representatives from thirteen different countries, emphasize the international character and high standard of the new periodical. Sir John Cockcroft, one of the United Kingdom representatives of the board, contributes a brief editorial to the first number of the *Journal* (pp. 144; July 1956), and W. B. Mann (U.S. National Bureau of Standards) is the author of the leading article, entitled "The Preparation and Maintenance of Standards of Radioactivity", in which he gives a historical survey of the preparation and measurement of international radium standards and explains the need for standards of other radioisotopes. A report is given of the present state of international comparison of several radioisotopes, and a policy for wider international comparison is discussed. There are nine other original articles dealing, respectively, with radioactive tracer techniques for sand and silt movements under water, particularly the use of powdered glass containing scandium-46; a radiochemical technique for determining the surface area of aluminium metal surfaces; liquid scintillators; labelled metabolic pools for studying the biochemistry of toxic action; the behaviour in the rat of plasma proteins labelled with carbon-14 and iodine-131; the production and clinical application of iodine-132; autoradiography; gamma-ray vulcanization of rubber; and an impulsion discriminator for activation analysis. The number concludes with the titles and abstracts of the papers presented to the third annual meeting of the Society of Nuclear Medicine, held during June 21–23 at Salt Lake City, Utah.

### *Automation Progress*: New Journal

'Automation' is an ill-defined word which no one likes and everyone uses. For the past three years, however, it has been a very live topic, and, as a result, existing journals have tried to persuade their readers that they cover at least a part of automation, and new journals with automation in the title have been appearing at frequent intervals in Europe as well as North America. The latest such periodical is *Automation Progress: The Journal of Automatic*

*Production and Control*, a monthly publication, the first number of which appeared last October (London: Leonard Hill Technical Group; 50*s*. a year). It is designed to fill the gap between highly specialized publications and the general technical press, in order to meet a long-felt need for a means of exchanging information between engineers and executives who have no time to follow the literature on any subject but their own. The first two numbers contain a number of interestingly written articles on problems of the automatic factory, and a vast range of equipment is described. There are also short digests of relevant articles in other journals, and of relevant patent specifications accepted, notices of forthcoming events, an editorial, "news briefs" and a cartoon. The new journal, therefore, not only provides interesting material for higher management interested in automation, but also brings together a great deal of information useful to development engineers working in the field. The format and arrangement of material are both good, and it is noteworthy that the American practice of mixing up advertisements and text has been avoided. It must, however, be emphasized that the number of journals dealing with automation in one form or another is now so great that it is quite impossible for any one man to read them all, although the amount of new and useful information available is probably not more than could be covered by a single journal, allowing for cross-references to and abstracts of specialized articles in periodicals covering other fields. Eventually, therefore, there may be a marked reduction in the number of journals purporting to cover the field of automation, and, from the engineer's point of view, the sooner this happens the better.

## Fisheries and Animal Husbandry in Japan

A LINKING of fisheries and animal husbandry may indicate a new and broadly based view of the development of natural resources or a 'marriage of convenience' possible only when traditional barriers have been removed by catastrophe. The University of Hiroshima established its Faculty of Fisheries and Animal Husbandry in 1949 at Fukuyama, on the shores of the Inland Sea and with a cattle-raising hinterland, and the Faculty began to issue a journal in 1955. From the first number it is difficult to visualize the proposed scope of work of the Faculty; its contents no doubt reflect the interests of staff rather than suggest an outline of its programme. T. Irie reports a study by X-rays and histochemical techniques of the crystal structure and texture of otoliths of the marine teleost *Pseudosciaena*; T. Fujiyama describes the life-history of and cytological studies on the monœcious plant *Prasiola japonica* Yatabe. Both these papers are in English. Y. Anagama contributes an extensive review, in German, of research on vitamin C in milk and milk products, in conjunction with the results of his own work. Two papers in Japanese, with brief English summaries, complete the number; of these the first, by S. Ono, describes the system and methods of selling calves by auction practised in Japan, while the second is a long account by M. Ikeda of "Studies on Properties and Agricultural Development of Alkali Soil in Manchuria", with numerous tables and text figures of which the legends are also in English, and 141 references of which only those of Oriental origin bear dates later than 1938. The journal is well printed and the illustrations, line drawings and plates, are clearly reproduced. In its present form and content it would seem more acceptable to central reference libraries than for circulation to specific interests; as an addition to the mass of literature in these fields it can be welcomed in so far as it gives a medium of publication for this group of workers.

## *Bulletin of Polish Medical History and Science*

POLISH medical literature comprises at present no less than thirty-nine periodicals, but only a few of these reach medical men and scientists outside Poland. It is for that reason that the Polish Medical Alliance, an organization with editorial offices in Chicago, decided to "present to the English-speaking physician the outstanding research works, both past and present, along with a résumé of the accomplishment of Polish medicine". The first issue of the *Bulletin of Polish Medical History and Science* (Vol. 1, No. 1; July 1956. Pp. 48. Polish Medical Alliance, 2424 N. Kedzie Avenue, Chicago 47, Ill. 1.50 dollars) contains, apart from abstracts from numerous papers which appeared in Polish journals, three original articles, of which the first, on "Nicolaus Copernicus, Physician and Humanitarian", has been written by the chief editor, Dr. Alexander Rytel.

## Alchemy and Early Chemistry

THE October issue of *Ambix, the Journal of the Society for the Study of Alchemy and Early Chemistry*, contains an appreciative obituary of the late Dr. F. Sherwood Taylor (who was editor from the inception of the journal in 1937) by the chairman, Dr. E. J. Holmyard. The new editor is Mr. D. Geoghegan. The number includes several interesting articles. The first, by Dr. Sherwood Taylor, is on the alchemical work of Isaac Newton and gives a transcription of a manuscript written by Newton which is apparently an attempt to form an intelligible body of doctrine from a number of quotations from alchemical authors, of which it mainly consists. Prof. Lynn Thorndike contributes a study of some alchemical manuscripts at Bologna and Florence. There are short articles on John Hariot's secret script by E. Seaton, and on J. B. Hunyades by Sherwood Taylor and C. H. Josten. An article on "Chymeutike, the real Hellenic Chemistry", by Procopios D. Zacharias, is a concise but detailed summary of publications by Prof. M. K. Stephanides, of Athens, which are otherwise available only in Greek. It attempts to put further back the beginning of chemistry, but is in error in saying that the famous Leyden Papyrus was found by Maspero (it was sold by collectors to Anastasy) and in dating it in the third century B.C. (it is dated by experts as A.D. 346). Stephanides suggested that the name 'chemistry' comes from the Greek *chymeia*, meaning 'preparing a *chyma*', and that the practice arose from the washing of auriferous sands in Egypt. The theory was based on old Greek philosophical ideas, Heraclitus and Democritus being connected with the development; the "Hellenic chymeutike has no connection whatever with Alchemy". Esoteric alchemy is represented in this number of *Ambix* by some reviews of books, including two on Lull, from the writings attributed (probably wrongly) to whom, it is said, much of English alchemical tradition seems to be derived.

## Two Palæolithic Sites in Lower Austria

VOL. 7 of the "Mitteilungen der Prähistorischen Kommission der Österreichischen Akademie der Wissenschaften" (Vienna, 1954–55) contains an

account of two palæolithic sites in Lower Austria, one near Kamegg in the Krems region and the other near Getzersdorf im Traisental. The former belongs to a very late palæolithic and can be grouped with the Hamburg series; the latter is rather older and can be classed as a late gravettian, so far as the upper levels are concerned, the lower level being somewhat older. Both sites are described by Dr. F. Brandtner, the actual description of the industries from Getzersdorf being by Dr. F. Felgenhauer. The illustrations of the tools found at Kamegg are excellent, those from Getzersdorf are indifferent. The whole forms a useful number with full descriptions of what are obviously important local sites.

## Observations on the Size of the Sun

While numerous workers have claimed to have detected variations in the diameter of the Sun, other investigators have failed to find any variations, or to detect any significant differences between the equatorial and polar diameters. A paper entitled "Greenwich Observations of the Horizontal and Vertical Diameters of the Sun", by P. J. D. Gething, of the Royal Greenwich Observatory (*Mon. Not. Roy. Astro. Soc.*, **115**, 5; 1955), gives the results of the yearly mean horizontal and vertical radii of the Sun observed at Greenwich from 1851 to 1939, but corrections for personality have not been applied. These are compared with observations for the horizontal semi-diameters of the Sun, made at Campidoglio since 1876, and later at Monte Mario; but there is no obvious agreement between the variations found at the two observatories. It has been claimed by Miss M. A. Giannuzzi, however, that the Greenwich observations of horizontal diameter contained an oscillation with a period of 22–24 years, agreeing in period and phase with an oscillation found from the Italian results, and a more detailed analysis of the Greenwich measurements of both horizontal and vertical diameters during 1915–36 was undertaken, in which allowance was made for the effect of personality and irradiation. The resulting diameters show that there were comparatively large variations from year to year; but it is emphasized that these variations do not necessarily represent real changes in the size of the Sun and may be due to variations in the mean personality correction. It is pointed out that Miss Giannuzzi's use of observations obtained by a large number of observers without applying personality corrections, on the assumption that changes in the mean personality corrections would be sufficiently small to be ignored, may not have been justified. A table in Gething's paper, which gives the horizontal semi-diameters corrected for personality, in the observations during 1917–36 by five members of the Greenwich staff, shows that the scatter around the combined mean of the individual means, when corrected for personality, is so large that the reality of the variations from year to year is untrustworthy. From the relative sunspot areas during 1917–36, it is seen that there is no obvious connexion between sunspot activity and the apparent variations in diameter. The conclusion is that Greenwich observations do not provide any clear evidence of real variation in the size of the Sun.

## Growth of Isolated Oat Embryos

In an investigation of amino-acids as sources of nitrogen for the growth of isolated oat embryos, G. P. Harris (*New Phytol.*, **55**, 2, 253; 1956) has found that ammonia, nitrate and casein hydrolysate were each effective as nitrogen sources. Casein hydrolysate was not inferior to the inorganic forms of nitrogen. A mixture of eighteen of the amino-acids present in casein hydrolysate was able to substitute for the latter as a nitrogen source for the growth of the embryos. The value of the mixture of amino-acids as a nitrogen source was dependent on interactions occurring between its constituent amino-acids. Out of twelve of the latter, all except arginine were markedly inhibitory to growth in length of the roots, when supplied alone. Marked antagonisms occurred between L-phenylalanine and L-tyrosine, DL-isoleucine and DL-valine, L-leucine and DL-valine, and L-arginine and L-lysine in their effects on root growth. Amino-acids which alone produced no, or relatively little, inhibition of root growth generally antagonized the effects of amino-acids which were more inhibitory.

## Geographical Association: Annual Meeting

The annual meeting of the Geographical Association will be held in the London School of Economics during January 1–4 under the presidency of Lord Nathan, who will speak on "Aviation and Geography: Reaction and Interaction". Among the topics to be discussed are: water supply in Britain (Prof. W. G. V. Balchin); techniques in field-studies (Dr. E. W. H. Briault); antarctic exploration (Mr. E. W. K. Walton); the International Geophysical Year (Dr. D. C. Martin); agricultural changes in the Chilterns (Mr. J. T. Coppock); economic development of Brazil (Prof. R. O. Buchanan); and geography and the social revolution (Prof. D. L. Linton). There will also be a discussion on "Geography and a Liberal Education". There will be the usual publishers' exhibition of books, maps and appliances, and exhibits of field-work, film strips, etc., by members of the Geographical Association. Further particulars of the meeting can be obtained from Mr. R. C. Honeybone, University of London Institute of Education, Malet Street, London, W.C.1.

## Conference of the Universities of Great Britain and Northern Ireland

The annual conference of the Universities of Great Britain and Northern Ireland will be held in the Senate House of the University of London during December 14 and 15. The topics for the three sessions are: "Overloading Curricula and the Length of Undergraduate Courses" (Sir Philip Morris, chairman of the Committee of Vice-Chancellors and Principals (*chairman*); Mr. R. B. McCallum, master of Pembroke College, Oxford; Prof. C. B. Perry, professor of medicine, University of Bristol; Prof. D. G. Christopherson, professor of applied science, Imperial College of Science and Technology, London); "Organization of Postgraduate Studies" (Dr. Constance M. Rigby, president of the Association of University Teachers (*chairman*); Sir James Mountford, vice-chancellor, University of Liverpool; Dr. D. A. Bell, Department of Electrical Engineering, University of Birmingham; Prof. F. S. Dainton, professor of physical chemistry, University of Leeds; Prof. E. R. H. Jones, Waynflete professor of chemistry, University of Oxford); "Impact on the Universities of the Government's Policy for the Expansion of Technological Education" (Dr. J. F. Lockwood, vice-chancellor, University of London (*chairman*); Sir Eric Ashby, president and vice-chancellor, The Queen's University, Belfast; Sir Harry Pilkington (*chairman*), National Advisory

Council for Industry and Commerce; Dr. Willis Jackson, chairman of the Joint Committee on the Supply and Training of Teachers for Technical Colleges). The conference is open only to delegates and to specially invited guests.

## Christmas Lectures

THE Christmas Lectures at the Royal Institution, Albemarle Street, London, W.1, will be given this year by Dr. H. Baines; the subject will be "Photography", and Dr. Baines is giving six lectures on Thursdays, Saturdays and Tuesdays, beginning December 27. At the Institution of Electrical Engineers, the Christmas Lecture for older schoolchildren will be given by Mr. J. F. Coales, of the Engineering Laboratory, University of Cambridge; he will speak on "Automation" and the lecture will be given on January 1 and repeated on January 2, at 3 p.m. Applications for tickets for Mr. Coales's lecture, which are free, should be sent to the Secretary, Institution of Electrical Engineers, Savoy Place, London, W.C.2.

## Oversea Service Division, Colonial Office

THE following appointments have recently been made in the Oversea Service Division, Colonial Office: N. Lawrence (scientific officer, Royal Observatory, Hong Kong), deputy director, Royal Observatory, Hong Kong; F. J. Parnell (assistant director, Game and Tsetse Control, Northern Rhodesia), director of Game and Tsetse Control, Northern Rhodesia; P. R. Adam, agricultural officer, Gold Coast; J. L. Anderson, agricultural officer, Western Region, Nigeria; M. G. Clough, agricultural engineer, Northern Region, Nigeria; R. Comber, agricultural specialist (plant physiologist), Gambia; P. G. Dennison, agricultural officer, Kenya; D. P. Drew, agricultural officer, Northern Region, Nigeria; W. M. Graham, entomologist, Maize and Produce Control, Kenya; F. N. Goodwin, agricultural officer, Northern Region, Nigeria; R. T. Harberd, agricultural officer, Northern Region, Nigeria; H. E. Hill, soil surveyor (Soil and Land Use Survey), British Guiana; S. P. Legg, livestock research officer, Ebini, British Guiana; K. R. Middleton, agricultural chemist, Northern Region, Nigeria; E. J. Mundy, agricultural officer, Northern Region, Nigeria; O. S. Swainson, principal, Farm Institute, Uganda; J. F. Ward, horticulturist, Department of Agriculture, Jamaica; R. B. Iles, scientific officer (zoologist), East Africa Fisheries Research Organization, East Africa High Commission; D. G. Almond, geologist, Uganda; H. P. J. Barr, assistant conservator of forests, Northern Region, Nigeria; P. B. Cruickshank, assistant conservator of forests, Gold Coast; R. M. Lee, assistant conservator of forests, Gold Coast; J. S. Scott, conservator of forests, Northern Region, Nigeria; O. Barnes, tsetse officer, Tanganyika; E. A. S. La Croix, entomologist, Tsetse Control Department, Gold Coast; P. L. Shinnie, director of antiquities, Ministry of Social Services, Uganda; B. Heyworth, veterinary officer, British Guiana; D. McManus, veterinary officer, Kenya; D. D. O. Pawson, veterinary officer, Tanganyika; J. H. Robb, veterinary officer, Western Region, Nigeria; L. F. Slater, veterinary officer, Uganda; R. C. H. Sweeney, section scientific officer, Nyasaland; W. Martin, senior technical assistant, Tuberculosis Research Unit, Gold Coast; P. Thomas, cocoa soil survey officer, Western Region, Nigeria.

## Announcements

SIR CHRISTOPHER HINTON, managing director of the Industrial Group, United Kingdom Atomic Energy Authority, has been awarded the Churchill Gold Medal for 1956 of the Society of Engineers, for his work on atomic energy.

DR. WILLIAM J. ROBBINS, director of the New York Botanical Garden and professor of botany in Columbia University since 1937, has been elected a trustee of the Rockefeller Institute.

MR. W. A. SANDERSON, an assistant director of the Nuffield Foundation, has been appointed secretary of the United Kingdom and British Commonwealth Branch of the Calouste Gulbenkian Foundation, which will be temporarily accommodated in Nuffield Lodge, Regent's Park, London, N.W.1.

THE following appointments in the University of Sheffield have been announced: Dr. A. Critchlow, to be lecturer in chemistry; Dr. A. R. Entwisle, to be lecturer in metallurgy. Dr. P. H. Price, lecturer in fuel technology, has resigned.

THE annual exhibition of laboratory apparatus and techniques arranged by the Manchester and District Section of the Royal Institute of Chemistry will be held in the College of Science and Technology, Sackville Street, Manchester, during 2 p.m.–8 p.m. on January 3 and 10 a.m.–8 p.m. on January 4.

THE Education Panel of the Corrosion Group of the Society of Chemical Industry is offering a prize of 25 guineas for an essay or paper on any aspect (not necessarily research) of corrosion of metals and its prevention. Competitors must not be more than twenty-seven years old, and their contributions, which may contain diagrams and photographs, should be approximately four thousand words in length. Entries must be submitted before March 31 to the Corrosion Group Essay Competition, c/o Society of Chemical Industry, 14 Belgrave Square, London, S.W.1, from which further information can be obtained.

THE Managing Trustees of the Drummond Fellowships for Research in Nutrition will consider in March 1957 applications for not more than one Drummond Senior Fellowship (£900 per annum) and not more than two Drummond Junior Fellowships (£500 per annum) for research in nutrition. The fellowships will normally be tenable for two years. Particulars can be obtained from the Honorary Secretary, Drummond Trust, University College, Gower Street, London, W.C.1. Completed application forms must be received not later than January 31, 1957.

RESEARCH papers on the chemistry and technology of oils and fats by a scientific worker in India are invited for consideration for the award of the Prof. T. P. Hilditch Medal. Such papers must relate to work carried out in the past two years, and should reach the convener of the award committee, Dr. D. R. Dhingra, H.B. Technological Institute, Kanpur, India, by December 31.

THE British Steel Castings Research Association has moved to new laboratories at East Bank Road, Sheffield 2.

A REVIEW of "The Chemistry of Living Cells" by Prof. Helen R. Downes was published in *Nature* of November 24, p. 1140. We are informed that the English publishers are Longmans, Green and Co., Ltd., and the price is 45*s*. net.

# NEW MAUNA LOA OBSERVATORY UNIT

By ROY L. FOX

Meteorologist in Charge, Pacific Area, U.S. Weather Bureau

A NEW high-altitude unit of the Mauna Loa Observatory to be used for observations and research projects was recently completed and dedicated. This unit, termed the 'slope' unit of the Observatory, is situated on the north slope of Mauna Loa at an elevation of 11,134 ft. above sea-level and is accessible over a gradual grade highway constructed of crushed lava and volcanic cinders. It is a companion unit to the much smaller and decidedly less accessible unit of the Observatory erected in 1951 at an elevation of 13,453 ft. near the summit of the mountain.

Its setting is the large volcanic mountain, Mauna Loa, often referred to as one of the largest single land masses in the world. The mountain comprises approximately half the island of Hawaii, the largest and south-easternmost of the Hawaiian Islands, and is noted not only for its massiveness but also for its very gradual slopes with almost constant grade. The 'straight line' average grade over a distance of approximately forty miles along the north-east slope from the summit, at 13,680 ft. above sea-level, to the sea in the vicinity of Hilo, the principal city on the Island, is less than 7 per cent. This is the slope traversed by the highway to the Observatory and also the one almost directly facing the prevailing quarter from which the trade winds in the vicinity of the Hawaiian Islands blow.

A trip up this highway to the 'slope' unit from Hilo carries one from a point near sea-level, where the average annual rainfall is 140 in., past the region of maximum rainfall near 3,000 ft. above sea-level, where it is more than 240 in., thence through a section of rapidly decreasing rainfall with height and then to the area from around 9,000 ft. to the Observatory unit, where the average annual rainfall is just under 20 in. The vegetation zones along the roadway serve as excellent climatic indicators and strikingly attest to these rainfall regimes. For the first 1,500 ft. or so of elevation the vegetation is predominantly shrub and closed forest. A dense tropical rain forest extends from around 1,500 ft. to near 5,500 ft. above sea-level, where vegetation begins to thin. Open forest then prevails for some distance, giving way to upland open shrub-type vegetation which, in turn, is replaced by a sparse growth of the primitive plant forms such as fungi, lichens and some mosses existing in the lava wastelands.

The 'slope' unit is housed in a pleasant one-story concrete block building, 20 ft. × 40 ft., partitioned into a 16 ft. × 20 ft. combination laboratory and workshop, three bedrooms and a combined kitchenette and dining room. There is also a ground-level concrete pad 15 ft. × 45 ft. for basing instruments, a raised wooden instrument platform and two instrument and antenna towers. It develops it own electrical power from its diesel-operated generating system. It also has its own radio communications link with the Weather Bureau Office in Hilo, an electrical lighting system and a water catchment and water storage and distribution units as well as a space heater, water heater, cooking range and refrigerator, all using butane.

The Mauna Loa Observatory is operated by the U.S. Weather Bureau, but at present it is not staffed on a fully continuous basis. Plans are, however, to have personnel regularly man the station and attend the instruments on four days of each week beginning in the very near future. For the remaining portion of each week, meteorological data will then usually be obtained, as they are now, by recording devices alone. However, for those periods when special research projects are being carried on at the Observatory by other groups through arrangements with the Weather Bureau, the meteorological instruments, along with other types of equipment, will be attended daily, and data on recorder records will be supplemented with visual data. Ultimately, if plans materialize, the Observatory will be staffed continuously, year in and year out.

The usual meteorological instruments, most with recording features, are now in use or soon will be in use at the Observatory. Data to be obtained on a continuous basis are wind speed and direction, pressure, temperature, humidity and rainfall. Additional data being anticipated for interrupted periods of several days per week are duration of sunshine, sky cover, cloud types and amounts, current weather and related features and pilot-balloon information. It is also expected that, when the Observatory is operated on a continuous basis, all these elements will be observed and/or recorded continuously, day in and day out, and that there will also be such additional measurements as those of solar radiation and ozone content of the air and that possibly some high-volume dust sampling and other dust measurements will be made.

Its accessibility, fine living accommodation and excellent provisions for basing instruments make this 'slope' unit particularly useful for special short-period projects. Other attractive features are its tropical location, its altitude—which is well above the usual height of the trade wind inversion in this tropical mid-Pacific area and which places it above much of the atmosphere's moisture and trade wind cumulus cloudiness most of the time—and its great distance from any large continental land masses and industrial areas.

The Observatory's high-altitude setting at a tropical location near the centre of the largest ocean on the globe makes it a unique facility. It is also less than a seven-hour trip from Honolulu, the travel hub of the Pacific, from which the first portion of the trip is by air to Hilo, thence up the mountain highway by motor-car.

One special project, namely, a series of spectrographic observations of the atmosphere of the planet Mars by a group of National Geographic Society scientists, has recently been completed at the Observatory. During the coming winter, it is hoped to study the structure of naturally formed snow crystals in an atmosphere with limited quantities of aerosols. Also arranged for next spring is a special study of solar radiation.

Preliminary negotiations for use of the 'slope' unit for a special project should be with the Chief of the Weather Bureau, by writing to the Chief of the Observations and Stations Facilities Division, U.S. Weather Bureau, Washington 25, D.C.

# AFRICAN VEGETATION

## MEETING AT YANGAMBI

THE study of natural vegetation, which has no regard for international boundaries, is of primary importance in the scientific development of Africa. It is therefore good to note that the Conseil Scientifique pour l'Afrique au Sud du Sahara, in conjunction with the Commission de Co-operation Technique en Afrique au Sud du Sahara, is now taking steps to promote international co-operation in this basic branch of science.

During July 29–August 8 this year a meeting of specialists in phytogeography was held in the Belgian Congo, under the presidency of Prof. J. Lebrun, secretary-general of the Institut National pour l'Étude Agronomique du Congo belge. The sessions were held at Yangambi, the African headquarters of the Institute, which is on the north bank of the Congo, about 90 kilometres downstream from Stanleyville, in dense evergreen rain forest. In 1885, H. M. Stanley wrote, "Yangambi is beautifully situated on a level terrace. The summits of the ridge appear to offer a charming field for European agriculturists". To-day the Institute's impressive organization at Yangambi employs some two hundred Europeans.

The member-governments of the two sponsoring bodies were represented by Prof. J. Lebrun (Belgium), Prof. J. Trochain (France), Dr. R. A. Dyer (Union of South Africa), Prof. P. W. Richards (United Kingdom), Dr. F. A. Mendonça (Portugal) and Prof. A. S. Boughey (Federation of Rhodesia and Nyasaland). The other participants were Prof. J. Millot, Prof. Th. Monod, A. Aubréville, Prof. R. Pichi-Sermolli, Dr. R. O. Whyte (Food and Agriculture Organization), R. W. J. Keay (sponsored by Unesco), and E. A. Bernard, Dr. R. Germain, E. Maudoux, R. Devred, L. Liben, C. Evrard and R. Gutzwiller, of the Institut National pour l'Étude Agronomique du Congo Belge.

In the field of plant taxonomy, international co-operation in Africa south of the Sahara is already well organized. The International Association of Plant Taxonomists and the Association pour l'Étude Taxonomique de la Flore d'Afrique Tropicale make important contributions towards this co-operation, the great national herbaria are in close contact with each other, and taxonomists—by and large—use much the same methods and concepts and accept comparable standards.

The position as regards plant ecology or phytogeography is, however, very different. There are, at the outset, considerable differences in the methods and concepts of the 'ecology' taught in British universities, largely influenced by Clements and Tansley, and the 'phytosociology' of the Braun-Blanquet school taught in most French and Belgian universities. The divergence has been aggravated by the fact that vegetation-mapping had been unfashionable in Britain during the past thirty years or so. British-trained botanists have, consequently, been going to Africa without much guidance on one of the first problems presented by African plant-life, so that ecological work has developed very individually in each territory. There is also a considerable difference, particularly outside the rain-forest regions, between the approach of the agriculturist who thinks of the vegetation as potential grassland, and that of the forester who thinks of the same vegetation as potential forest.

Much literature and many vegetation maps have been produced in recent years, but it is extremely difficult to correlate the work done by different authors, even in neighbouring African countries. The initiative taken by the Counseil Scientifique pour l'Afrique au Sud du Sahara in promoting international understanding in these matters is therefore most welcome.

The meeting at Yangambi was preceded by an interesting and well-organized excursion to the Haut-Uele Province in the north-east Belgian Congo. After examining forests near Stanleyville, the party travelled by air 350 km. north-east to Paulis. This important centre for *Coffea robusta* and cotton plantations lies in the rain-forest zone, and it was only after the party had travelled about 75 km. toward Dungu that the first savannah vegetation was seen. All agreed that this vegetation and much of that seen on the journey (210 km.) next day to Aba had been derived from closed forest by man's farming and grass-burning activities; there was, however, a good deal of argument about the precise nature of the climax. Near Aba, the party saw a most interesting outlier of semi-evergreen rain-forest at Kurukwata, and later an example of the *Isoberlinia doka* woodlands, which are characteristic of a distinct belt stretching from French Guinea to Uganda and correspond to the well-known 'myombo' woodlands of east, central and southern Africa.

This excursion, and two trips near Yangambi, provided a unique opportunity for some of Africa's leading ecologists to see together a good range of vegetation types and to discuss them in the field, while travelling, and at the end of each day. This field-work provided an excellent basis for the more formal meetings at Yangambi. There was a considerable measure of agreement concerning the recognition in the field of the plant communities and how they are influenced by biotic, edaphic and climatic factors. It was encouraging to find that on many points workers had independently come to similar conclusions. The greatest divergence of opinion was in matters concerning nomenclature and the concept of the climatic climax. The informal discussions about the latter more academic point were particularly lively and valuable.

Matters of nomenclature were dealt with in the formal sessions at Yangambi. MM. Aubréville, Trochain and Monod each presented classifications of the main types of tropical African vegetation. These and other participants worked hard during the meeting to produce a classification of physiognomic types with parallel names and diagnoses in French and English. This agreed synthesis is to form a basis for a synopsis of tropical African vegetation, illustrated by profile diagrams and photographs, which, it is hoped, M. Aubréville will shortly prepare for publication.

Prof. Monod presented a remarkable account, intended for publication, of the chorological divisions, that is, the broad patterns of distribution not only of the vegetation and plant species but also of the animals.

The meeting reviewed the present state of vegetation-mapping in Africa south of the Sahara and proposed the creation of a permanent centre in Africa to which all new maps of interest to phytogeographers would be sent, and from which research workers could borrow maps. It also considered proposals for the preparation of a botanical atlas of Africa, including vegetation maps on a scale of 1 : 5,000,000, as well as

maps showing the distribution of economic species and other subjects.

The Conseil Scientifique pour l'Afrique au Sud du Sahara, and in particular Prof. Lebrun, are to be congratulated on organizing such a useful meeting, and it is to be hoped that means will be found to implement many of its recommendations.

R. W. J. Keay

## NINTH INTERNATIONAL CONGRESS OF APPLIED MECHANICS

THE ninth International Congress of Applied Mechanics was held at the Université Libre of Brussels during September 5–13. More than seven hundred members attended the Congress, and no less than five hundred communications were presented. The Congress was administered by the International Committee for Congresses of Mechanics, which is one of the organizations adhering to the International Union of Theoretical and Applied Mechanics. The president was Prof. F. van den Dungen and the secretary-general M. Jean Vandenkerckhove. A feature of the organization was the special provision which was made for young scientists, who were able to obtain cheap accommodation and meals in the Cité Universitaire, while a grant of 2,000 dollars was also available to help with their expenses of travelling to Brussels.

The main interest of the Congress naturally centred around the one-hour addresses. Mr. K. S. Davidson, of the Stevens Institute of Technology, Hoboken, N.J., gave a lecture on "Ships", in which hydrodynamics, boundary-layer theory and practical yachtsmanship were pleasantly combined. Much of the substance of this lecture is available in the Sir Geoffrey Taylor Memorial Volume entitled "Surveys in Mechanics" (Cambridge University Press, 1956).

Prof. R. Hill, of the University of Nottingham, gave a lecture on "New Horizons in the Mechanics of Solids". In this lecture he set up a theoretical framework sufficiently general to include problems of visco-elastic solids, including the theory of creep and work hardening.

Prof. P. Germain, of the University of Lille, lectured on "Some Recent Advances in Theoretical High Speed Aerodynamics". This was a general survey of problems of linearized supersonic theory treated by the method of the Laplace transform. Some extensions to second-order effects were also included in the lecture, which was remarkable for the speed with which it covered almost all recent developments in this subject.

Prof. H. Mettler, of the Technische Hochschule, Karlsruhe, spoke on "Forced Non-linear Vibrations of Elastic Bodies".

But perhaps the address which was most appreciated was that by Sir Geoffrey Taylor, which bore the title of "Steady Flow of Fluid entering a Region through Porous Boundaries", and which in fact dealt with the hydrodynamics of paper-making, and of painting with rollers and ordinary artists' brushes. In this extremely interesting address, Sir Geoffrey gave an account of the recent work which he has carried out to investigate the flow of the paper pulp over the rollers in paper-making machines. His investigations of roller painting and of brush painting consisted not only of simple theories embodying the main physical factors, but also of experiments which satisfactorily bore out the predictions of the theory and which were remarkable for the economy of material with which they were executed.

Apart from these general addresses, the work of the Congress was divided into two sections, the first dealing with fluid mechanics and containing some 258 papers, and the second with the mechanics of solids, containing 243 papers. In view of this great mass of material, it was necessary to limit the time available for the presentation of most papers to 15 minutes, although a certain number were given 30 minutes. The papers were grouped in such a way that only two papers were ever being read at the same time, namely, a 30-minute paper in Section I and a 15-minute paper in Section II, or vice versa.

The section on fluid mechanics included papers on aerodynamics in subsonic, transonic, supersonic and hypersonic conditions, on atmospheric pollution, boundary-layer theory, hydrodynamics of water-entry problems and surface waves, lubrication, cavitation, and seepage problems in the Nile valley. A particularly interesting demonstration was given by Prof. M. Reiner, of the Israel Institute of Technology, of his centripetal pump. This machine consists of two parallel plates ground accurately flat, of which one forms the stator and the other the rotor. A pressure hole is located at the centre of the stator and the rotor is rotated at a few thousand revolutions per minute. Initially, the pressure at the centre of the stator is reduced; but as the distance between the plates is progressively reduced to a few thousandths of an inch, a pressure of several feet of water is built up.

The section on the mechanics of solids included some papers on classical problems of vibrations, on the elastic theory of plates and shells, on buckling and post-buckling problems, and on a yielding subsoil; but the emphasis seemed to be on plasticity, limit analysis, creep and visco-elasticity.

Mention must also be made of the social activities and of the financial support which the Congress received from Belgian banks and industries. Members of the Congress enjoyed the traditional Belgian hospitality at two receptions and a banquet. A reception was given at the University by the President, Vice-President and Rector of the Free University of Brussels and a reception at the Town Hall by M. L. Cooremans, mayor of Brussels. The banquet was held at the Hotel Metropole.

It is planned to hold the next International Congress of Applied Mechanics in 1960 in Italy.

## THE NUCLEI OF ATMOSPHERIC CONDENSATION

ATMOSPHERIC aerosols cover a wide range of particle-size from about $10^{-7}$ cm. for the small ions to more than 10$\mu$ radius for the largest salt and dust particles, and a range of concentrations from less than 100/cm.$^3$ over the oceans and in the upper air to, perhaps, $10^6$/cm.$^3$ in the polluted air of large cities. Being the products of natural and man-made combustion, of dust and spray raised from the Earth's surface, of chemical reactions taking place in the

atmosphere, and perhaps even of matter entering the atmosphere from outer space, the particles will vary greatly in chemical composition and, because of coagulation, will often be of mixed constitution. The abundance, size, physical properties and nature of these particles are matters of particular interest to those working in the fields of cloud physics, atmospheric electricity, atmospheric pollution and atmospheric chemistry.

Since the pioneer work of Aitken seventy-five years ago, a great deal of effort has been devoted to measurement of the concentration, size, mobility and electric charge of the smaller particles with radius between $10^{-7}$ and $2 \times 10^{-5}$ cm. But in recent years more attention has been given to the particles larger than $0{\cdot}1\mu$ in diameter—the so-called 'large' and 'giant' nuclei—since it is these which are mainly responsible for the formation of cloud droplets. The selective sampling of these larger particles has necessitated the development of new techniques for collection and measurement; but at these sizes it now becomes possible to use electron microscopy, electron diffraction and microchemical methods for identification.

These trends were reflected in the proceedings of the Second International Symposium on Condensation Nuclei, held in Basle and Locarno during October 1–4 and attended by scientists from ten countries.

After the delegates had been welcomed by Prof. F. Verzár on behalf of the organizing committee, the conference opened with a review by Dr. B. J. Mason (Imperial College, London) in which he summarized and assessed the present state of knowledge concerning the abundance, size distribution, physical properties, nature and origin of condensation nuclei, particularly of those which are likely to be involved in cloud formation.

An interesting paper by A. C. Chamberlain, W. J. Megaw and R. D. Wiffen (Harwell) described the consequences of the attachment of radioactive particles (particularly the decay products of radon and thoron) to condensation nuclei, the use of radioactive markers to study the behaviour of condensation nuclei, and the production of condensation nuclei by ionizing radiations. The diffusion constant of radium A and thorium B ions was found to be 0·054 cm.²/sec. when uncombined, and of order $10^{-5}$ cm.²/sec. when attached to condensation nuclei, this difference having an important effect on the site of deposition in the human respiratory system of inhaled radioactive matter. Unattached radioactive particles are largely deposited in the nose, trachea and bronchi, but the attached particles penetrate to the alveoli. The new radioactive method of determining the diffusion constant of nuclei gave results which differ from those obtained by the normal methods by a factor of about two—a discrepancy which has still to be resolved.

Reviewing the methods of measuring the concentration of Aitken nuclei, Prof. L. W. Pollak (Dublin) stressed the limitations of the Aitken pocket counter and of the Schulz counter and described the development, calibration and accuracy of the Nolan–Pollak photoelectric counter, which has proved a much more satisfactory instrument. There followed papers by various members of the Dublin school describing a nucleus counter with stereophotographic recording of the deposited droplets, the formation and decay of the fog in the photoelectric counter, and the results of some experiments carried out with Verzár's automatic photoelectric counter.

There were two other papers of particular interest from the instrumental point of view. Prof. A. Goetz (Pasadena) described an ingenious device for the separation and size classification of airborne particles greater than $0{\cdot}2\mu$ diameter. The particle-laden air is introduced into the space between a helical screw and an outer cylinder rotated at high speed. The particles are deposited on the surface of the helix under a centrifugal acceleration, the linear displacement being proportional to the ratio particle diameter/mass. Under these conditions, the particles move only slowly relative to the air and so are not subjected to large shearing forces.

Dr. J. Podzimek (Prague) described some preliminary experiments on the formation and growth of clouds produced in Findeisen's large expansion chamber (capacity 2 m.³) and, in particular, the effects of varying the initial temperature, expansion ratio and rate of expansion (that is, the rate of cooling of the air).

The role of condensation nuclei in atmospheric electricity, and in particular the effect of their concentration, charge and mobility on the conductivity of the air, was the subject of papers by H. Israël (Aachen), J. A. Chalmers (Durham) and Herpertz, Israël and Verzár.

Dr. C. Junge (Air Force Research Center, Cambridge, Mass.) described the results which have emerged from the chemical analysis of samples of rain-water collected once a month at some sixty stations spaced across the whole of the United States. Maps showing the geographical distribution of chlorides are very similar from month to month, with high concentrations near the coast, but dropping to a fairly constant value inland. This, together with the fact that the total number of giant salt particles occurring in unit vertical column of the atmosphere is much the same over both land and sea, suggests that the air undergoes strong vertical mixing when it passes over the continent, and also that the giant salt particles are not effectively removed from the atmosphere by rain. Junge estimates the mean half-life of the giant salt particles to be three to four days in the eastern part of the United States, where the average rainfall is 0·1 in./day, and six to seven days in the western part of the continent, where the average daily rainfall is only 0·05 in. The half-life of the smaller natural aerosols, measured by radioactive techniques, was estimated to be about twelve days. This all suggests that natural aerosols may be transported for great distances over the Earth before falling out or being washed out by precipitation.

During the second part of the conference, held in Locarno, Prof. Giuseppina Aliverti (Naples) reviewed recent researches on the condensation and ice-forming nuclei which are of particular interest in cloud physics.

Dr. B. J. Mason (London) reopened the old controversy as to whether salt particles produced by sea spray are the main source of condensation nuclei involved in cloud formation. His experiments show that air bubbles of diameter between $\frac{1}{2}$ mm. and 2 mm., bursting in sea water, each produce about three hundred nuclei which, under the electron microscope, are mainly between $0{\cdot}1\mu$ and $0{\cdot}5\mu$ in diameter, the smallest containing only $10^{-15}$ gm. of sodium chloride. These results, together with measurements of the size distribution of salt nuclei collected over the oceans in areas of spray formation, indicate that the total concentrations of salt nuclei over the oceans in winds of up to 15 m./sec. probably do not

exceed 100/cm.³. The corresponding rate of production of salt nuclei at the sea surface is estimated to be 1,000/cm.² sec. It was therefore inferred that sea-spray contributes perhaps only one-fifth of the nuclei involved in cloud formation, the majority being the products of combustion.

A paper by K. Isono (Tokyo) described how the residues of cloud droplets collected on the summit of a mountain 150 km. from the sea have been examined under the electron microscope and their nature determined by electron diffraction. Most of the nuclei are less than 1μ in diameter; about 30 per cent consisted of sodium chloride, 20 per cent of unidentified soluble particles, and 50 per cent of insoluble particles—probably combustion products.

H. Dessens (France) has established that giant hygroscopic nuclei ($r > 10\mu$) exist in concentrations of at least 100/m.³ in the equatorial forests of the Belgian Congo, while nuclei of radius less than 0·4μ are present in much higher concentrations. No sodium chloride crystals have been identified among the giant particles, the most important source probably being the savannah fires. M. Dessens also described some very interesting experiments in which he has been able to produce quite large cumulus clouds in an otherwise clear sky by the burning of vegetation.

Other aspects of the subject were represented by contributions from H. W. Georgii (Frankfurt) on the measurement of the turbulent diffusion of aerosols near the ground, and by F. Volz (Mainz) on the production of dusts and their spatial distribution in the atmosphere.

Although a good deal of the material presented was not entirely new, the conference produced much vigorous and good-humoured discussion and some clarification and agreement as to what are the important problems. These include the collection and identification of the large and giant nuclei over both land and sea at different levels in the atmosphere, and investigation of the processes by which they are produced and transported.

The organizing committee is to be congratulated on the excellence of the arrangements in ideal surroundings. The proceedings of the conference will be published in a special issue of *Geofisica Pura e Applicata*. It is expected that the next symposium will be held in Britain in 1958. B. J. Mason

## WORLD TELECOMMUNICATION

THE major part of the inaugural address as president of the Institution of Electrical Engineers, delivered by Sir Gordon Radley, director general of the Post Office, on October 4, was devoted to a consideration of world telecommunication, a subject particularly topical in view of the recent opening to traffic of the first trans-Atlantic telephone cable. The practical realization of inter-continental multi-channel telephone communication by submarine cable is, in Sir Gordon's view, revolutionary in its possibilities, because the traffic capacities of such cables are likely to exceed the existing demand for telegraph and telephone facilities on their routes. It is important to appreciate that it is the advent of the submerged repeater or amplifier which has rendered long-distance submarine telephony practicable. The attenuation of the Newfoundland–Scotland section of the trans-Atlantic telephone cable at 164 kc./s. is approximately 1·6 db. per nautical mile, and an input power at the enormous level of 100 MW. would not be detectable by the most sensitive galvanometer at a distance greater than 150 miles. In the cable, repeaters are inserted every 38 miles, and the gain of each of these is 65 db., representing a power amplification greater than $10^6$. On this basis multi-channel telephony is practicable on the longest submarine circuits.

The trans-Atlantic cable circuit utilizes, for the longest ocean link, separate cables for the two directions of transmission. The 'one-way' repeaters in these cables are accommodated in flexible housings only a little larger in diameter than the cable itself. These repeaters can be passed over the laying gear of the cable ship, and laying can be carried on continuously as with a conventional cable. The alternative arrangement of two-way transmission on a single cable requires a considerably greater space in the repeater housing to accommodate the additional filters and more complex circuits. The rigid housings for these repeaters require special handling in laying and considerably complicate that operation. The devising of means whereby the laying of such rigid repeaters could be carried out as part of a continuous cable-laying operation is, in fact, an immediate task of great importance.

Sir Gordon devoted considerable attention to the relative costs of single- and double-cable schemes, illustrating the matter by curves showing the estimated capital cost and annual cost per telephone circuit for cables 2,000 miles long, plotted to a base of total band-width transmitted in each direction. The cost per circuit is shown to decrease rapidly as the band-width or total capacity of the system is increased. It is thus economically advantageous to include in one cable, or pair of cables, all required facilities, telegraphy, telephony and—ultimately—television.

In regard to the economics of telephone-cable schemes on the main cable routes of the world, there appears to be a marked distinction between the North Atlantic route and all others. Sir Gordon remarked that the impetus to the growth of traffic between Western Europe and North America given by the 1956 telephone cable might well produce an early demand for a second cable of the greatest capacity technically possible. Eighty circuits in a single-cable system or two hundred in a twin-cable system was an objective only just beyond the limits at present imposed by repeater spacing and cable diameter, and either system, if reasonably loaded with traffic at the present call-rates, would be profitable.

On other world routes the economic prospects are less promising. Circuits to Australia and New Zealand, 12,000 miles long, might have a volume of traffic between 5 per cent and 10 per cent of the traffic with North America. It is clear that, for so great a distance with a small group of circuits, cable could not be competitive on cost with radio. On the other hand, experience of the propagation of high-frequency waves has shown that satisfactory radio communication cannot be maintained continuously over such difficult routes as the North Atlantic, or to the Antipodes.

It thus appears that the challenge to the communication engineer is that of providing submarine cable facilities on the main trunk routes of the world on a similar scale to that which has become established practice on land. This challenge is of very direct concern to British manufacturers, for Britain has a unique tradition of submarine cable manufacture

and has an exceptionally large manufacturing capacity for this class of equipment.

In relation to inland telecommunication, Sir Gordon stated that "electronic techniques are likely to revolutionize the art of telephone switching within the foreseeable future". Fully electronic switching systems are being developed along two distinct lines, one in which gas diodes or other corresponding devices are used in a 'space multiplex' to connect speech paths, and the other in which time-division multiplex operation enables individual subscribers to communicate. The production cost of an electronic exchange is likely to be less than that of the corresponding mechanical equipment, and it is thought that maintenance costs should also be reduced.

A new facility is planned for the trunk telephone network of Great Britain in the form of subscriber-dialling of long-distance calls. To render this practicable, it is necessary to have a nation-wide number scheme, and the system is being planned on the basis of 20 million subscribers connected to 8,000 telephone exchanges.

In the trunk network, co-axial cables carrying 600 speech channels are in operation between the main centres of population, and similar plant modified to transmit a slightly wider band of frequencies is used for television. It is proposed, on these co-axial cable routes, to reduce the spacing between repeater stations to three miles, if sufficient traffic offers, as this would enable each tube of the cable to carry 1,000 telephone channels plus a 405-line television channel. The micro-wave radio relay system planned for Britain is capable of carrying 600 channels of telephony, or one television channel.

In his concluding remarks, Sir Gordon mentioned that he had not followed the example of his predecessors in office during the past few years as he had made no reference to the great need in Britain for more technologists, or to the means of training them. He had, however, described a few of the problems and projects which at present are challenging the ingenuity and energy of the telecommunication engineer, and he hoped that in so doing he might have kindled here and there a spark of interest and enthusiasm for work in a field of endeavour where much can be done to serve the nation, the Commonwealth, and the world at large.

J. GREIG

## CITY AND GUILDS OF LONDON INSTITUTE

THE year 1955 was a memorable one for the City and Guilds of London Institute in that the entries for the Institute's examinations exceeded a hundred thousand for the first time. From 1878 until 1955 more than 1¼ million people have entered for the Institute's examinations, and the fact that half a million of these have done so within the past six years emphasizes how great has been the expansion of technical education. During the year many new subjects have been introduced to meet new needs, and a large number of existing subjects have been carefully reviewed and where necessary the syllabuses have been modified.

The Institute regularly surveys its schemes not merely as separate subjects but also in their relationship to each other and in relation to their place in the national economy. As an example, some account is given in the annual report of those subjects which have a particular bearing on the proper use of the nation's fuel resources and the contribution which appropriate courses of study can make to industrial fuel efficiency.

The Associated Examining Board for the General Certificate of Education, for which the Institute has undertaken the administrative and financial responsibility in the initial years, has now been successfully launched. In the first examination, held in the summer of 1955, nearly five thousand papers were taken in more than seventy subjects at ordinary and advanced levels, and the entry figure has been more than doubled in the summer examination of 1956. Omissions in the list of subjects offered by the Board are continually being made good, and the new subjects recently approved include commercial subjects (including shorthand and typewriting) at ordinary level, music at ordinary level, and dress at ordinary and advanced levels.

The report also contains an account of the way the Institute has been re-organized to meet the challenge of changing times.

## NITROGEN METABOLISM AS AFFECTED BY POTASSIUM DEFICIENCY

SOME new and interesting aspects of nitrogen metabolism in barley, especially as it is affected by potassium deficiency, have been investigated by R. G. Coleman and F. J. Richards (*Ann. Bot.*, N.S., **20**, 79, 393; 1956). Barley was grown in water and sand culture, using a variety of nutrient solutions, the most important variable being potassium supply. It was observed that the diamine putrescine, which is not normally found in this plant in appreciable amounts, was present in potassium-deficient seedlings and that it accumulated during their growth. Its maximum accumulation coincided with the development of the severe symptoms associated with advanced deficiency. Putrescine occurs at an earlier stage in potassium-deficient plants, the nitrate and phosphate of which are supplied as ammonium salts, than in those to which the corresponding calcium salts are given. It is found less abundantly in the roots than in the tops. It is absent from protein hydrolysates.

These investigators have also shown that a leaf necrosis characteristic of potassium deficiency can be induced by feeding putrescine to barley having a high potassium status; after prolonged feeding the appearance of such plants suggested severe potassium starvation. The putrescine is slowly utilized, and at the same time an unidentified substance is produced. It is stated that what seems to be the same substance appears in quantity in high-potassium red clover during the course of rapid utilization of administered putrescine. It also occurs naturally in potassium-deficient red clover. When potassium is supplied to potassium-deficient barley in which putrescine has accumulated, the amine soon disappears. Application of either rubidium or sodium also leads to a reduction in putrescine, though to a lesser extent, rubidium being the more effective element. Under conditions of extreme potassium-deficiency, wheat and red clover also accumulate putrescine. The free amino-acid composition of the wheat then bears a striking resemblance to that of deficient barley.

## PHYSIOLOGY OF MUSCLE

THE Medical Department of the British Council has once more been able to persuade a group of active and distinguished scientists to leave their benches and spend time on summarizing and interpreting recent progress in a field of active research—this time, the physiology of voluntary muscle (*British Medical Bulletin*, **12**, No. 3, 161 (1956). London: British Council. 15*s*. net). There are sixteen reviews in this symposium, and they succeed in giving a clear, connected and up-to-date summary of research in the physiology, biochemistry and biophysics of this type of muscle. The scientific editor is W. D. M. Paton, and the chairman of the planning committee is Sir Rudolph Peters, who contributes an introduction.

A. V. Hill contributes essays on thermodynamics and on the design of muscles. He mentions that an animal's muscles could be quickened about 20 per cent by raising its body temperature 2 deg. C., and he wonders whether, if this were achieved rapidly by diathermy, it would enable a good runner to do 100 yards in 8 seconds. He points out, though, that the margin of safety in mechanical strength of muscle systems is a small one and thinks that the experiment would be risky. There is an essay by A. F. Huxley, illustrated by photomicrographs, on the interpretation of muscle striations, based on work with modern techniques of light microscopy. This is followed by one on the 'ultra-structure' of muscle as revealed by the electron microscope and the X-ray camera (H. E. Huxley). It is possible by means of suitable salt solutions to extract the main proteins of muscle selectively, so that the residual structure can be viewed after successive removal of myosin and actin. The results suggest a delightfully simple picture of muscle as being made up of discontinuous, parallel filaments of myosin and of actin which seem to slide or 'crawl' past one another during contraction, perhaps because of the pull exerted by oblique cross-linkages between the molecules of the two proteins. Adenosine triphosphate can affect this interaction and may itself be broken down by myosin. The word 'crawl' would scarcely seem apt to R. G. Bannister, who contributes a section on muscle effort in running. In spite of the limits set by speed of muscle contraction or of oxygen supply, he believes that in a race, psychological factors—mental excitement and ability to ignore pain—"set the razor's edge between defeat and victory".

Mrs. D. M. Needham describes the biochemical reactions which provide energy for muscle contraction. In the past, glycogen and creatine phosphate have successively been displaced from the role of primary energy source in muscle. Whether adenosine triphosphate will suffer the same fate remains to be seen, though there are hints of this in the work of H. A. Krebs and his colleagues and of W. F. H. M. Mommaerts (see *Nature*, **174**, 1081; 1954). At present, adenosine triphosphate seems to occupy the key position even after death, and E. C. Bate-Smith and J. R. Bendall show that the onset of rigor depends on the fall in the concentration, or in the turn-over rate, of this substance to a critical level. Other biochemical features of muscle are considered by K. Bailey and by S. V. Perry in their essays on the protein and enzyme systems of muscle.

The comparative physiology of muscle is discussed by C. F. A. Pantin and the methods of locomotion in fishes and four-footed animals by Sir James Gray. The role of the cell membrane is described by B. Katz, particularly the phenomenon of liberation of acetylcholine in quanta or 'pre-formed parcels' at the nerve–muscle junction. The only article of immediate clinical application is the one on familial periodic paralysis by B. McArdle, though Sir Rudolph Peters points out in his introduction that most of the academic research reviewed in the other essays is needed to provide a basis for complete understanding of this one disease.

Most of the reviews contain an up-to-date and fairly extensive bibliography, which greatly adds to their usefulness. D. C. HARRISON

---

## SENSITIVITY OF IMMATURE MOUSE SPERM TO THE MUTAGENIC EFFECTS OF X-RAYS

By DR. A. J. BATEMAN*

Cytogenetics Department, Christie Hospital and Holt Radium Institute, Manchester

IN an earlier communication[1], I questioned the accepted view that the first three weeks mating of a male mouse irradiated with a dose in the neighbourhood of 500 r. represented *all* the post-meiotic stages of sperm at the time of irradiation[2,3]. My objection was based upon data being accumulated at the time and which can now be presented.

The mutagenic response was studied in terms of dominant lethals. Twelve days after their insemination, females were dissected and the numbers of corpora lutea, implantation sites and dead implants recorded. From this last category were excluded fœtuses which had made appreciable growth before death. In so far as they are genetic in origin, these would arise from gene mutation rather than chromosome breakage and loss, which is the source of the main type of dominant lethal mutation.

It is usual (for example, Russell *et al.*[3]) to estimate the proportion of dominant lethals from the corpora lutea not represented by live fœtuses. This will include all dominant lethals; but unfortunately it will also include all unfertilized eggs. There is likely to be a substantial and erratic proportion of unfertilized eggs even in the control series (matings of unirradiated males), which is therefore an important source of random error. But if the treatment affects the amount of sperm, its fertilizing capacity, or even its ability having effected fertilization to promote cleavage, there is the possibility of a systematic error.

* British Empire Cancer Campaign Fellow.

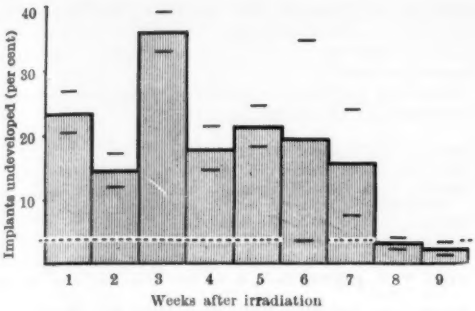



Fig. 1. Dominant lethal rates in successive weekly samples of sperm following the irradiation of male mice with 200 r. The broken line shows the control value : 5·78 per cent. The standard errors of the weekly means are indicated by the thin horizontal lines above and below

In the data here presented, only the proportion of implantations without signs of a fœtus is considered. While excluding in this way about half the true dominant lethals (those failing to be implanted) the above-listed sources of error are also excluded, and the control value is conveniently low and constant. There is one important unproved assumption : that the frequency of failed implantations is proportional to the *total* incidence of dominant lethals. There is some evidence that this is approximately true. Meanwhile, the convenience of the method is a good recommendation. The only improvement would be a method which was able to distinguish between unimplanted eggs due to dominant lethals and those due to other causes, which would probably necessitate the cytological examination of all the eggs at a critical stage after fertilization.

Both irradiated males and the females to which they were mated were $F_1$ hybrids between two large-bodied strains supplied by Dr. D. S. Falconer of Edinburgh. They are vigorous, mate readily and have high ovulation-rates. The modal number of corpora lutea is 14–15.

The males were given a testis dose of 200 r. They were then placed with four females each, which were renewed at weekly intervals for nine weeks.

Nine males were analysed in this way. There was no indication of heterogeneity between them. The mean weekly values for dominant lethals for all males are presented in Fig. 1, with the standard error based on variation between males.

The most important feature is the continuous incidence of dominant lethals over seven weeks, followed by a return to the control value by the eighth week. It is accepted that dominant lethals induced in pre-meiotic stages are not transmitted by the sperm. The detection of dominant lethals is therefore proof that these sperm were in a post-meiotic stage or, possibly, meiosis at the time of irradiation. It is concluded, therefore, that, contrary to many shorter estimates, spermiogenesis from spermatocyte to insemination in the mouse takes six weeks.

It may be objected that no allowance has been made for the possible storage of sperm after it has matured, thus producing an extension of the apparent length of the post-meiotic period. This assumption of sperm storage is common in the literature and is implied in all data in which matings are analysed according to mating sequence rather than the interval from irradiation[2,5]. There may well be stock differences in this matter ; but my own material shows no evidence of the storage of sperm. On the contrary, it shows clear evidence that there is *no* storage.

Males given 500 r. become completely sterile after three weeks, whether or not they have been mated previously. Moreover, the raised mutation-rate detectable in the third week is also found to be independent of the previous mating history. This absence of storage is consistent with the anatomy of the genital system, which has no storage organ, the so-called 'vesiculæ seminales' being secretory organs containing material for the vaginal plug.

If spermiogenesis takes six weeks, it follows that the failure to obtain progeny from males over three weeks from irradiation with doses of the order of 500 r. must be due to the lethal effect of such doses on immature sperm, in much the same way that 30,000 r. kills immature *Drosophila* sperm[4].

Fig. 1 shows a marked peak in mutation for the third week. This confirms the observations of Auerbach and Slizynski[3] for translocations, and that of earlier workers[2,5] for dominant lethals, following higher doses. In the present data the mutation-rate in the third week is more than twice that in the second.

After this peak, however, the mutation-rate falls in the fourth and fifth weeks to a level indistinguishable from that of the two weeks before the peak. Evidently the mutagenic sensitivity of the earliest stages of spermiogenesis is no greater than that of mature sperm. It is only at a certain critical stage, 2–3 weeks from maturity (week 3 samples sperm utilized 14–21 days after irradiation), that hypersensitivity is encountered. This is in direct contrast to *Drosophila*, where the peak sensitivity is found in the most immature spermatids.

Pronounced oligospermy is encountered during weeks 6 and 7. This explains the high standard error for these weeks. Owing to this high error we can say nothing more definite regarding the mutation-rate at this stage than that it is not significantly different from that of the two preceding weeks. Owing to the oligospermy there is a high degree of pseudopregnancy (more than 50 per cent), and the fertile matings have implantation-rates of only 40 per cent. Indeed the paucity of sperm was so great that none was found in the uteri of females shortly after insemination, though similar samples during all the other weeks showed abundant sperm. This is independent evidence that weeks 6 and 7 are close to meiosis, irradiation of which has been shown by Auerbach[6] to lead to oligospermy in *Drosophila*.

A minor point is the barely significant reduction in mutation from the first week to the second. The difference is $8{\cdot}9 \pm 4{\cdot}2$ per cent. Such an effect has been frequently encountered in *Drosophila* in comparing the first and second days mating[4,7].

To return to the main features of Fig. 1, it would appear that the variation in mutagenic sensitivity during spermiogenesis is *not* the same in mouse and *Drosophila*. A possible objection is that our assumption of a constant ratio of pre-implantation to post-implantation losses due to dominant lethals is not a valid one. But one would have to invoke extreme variation in the ratio to transform a *fall* in the ratio of post-implantation lethals to total implants into a *rise* in the total frequency of dominant lethals.

Another possibility which must be considered is that the recovered mutation-rate is not the primary one. Thus in sperm more than three weeks to maturity there might be selective elimination of those

carrying dominant lethals. This possibility needs to be investigated further.

It may be concluded that spermiogenesis in the mouse takes 6–7 weeks. This is the period during which dominant lethals can be detected following a testis dose of 200 r. Unlike *Drosophila*, the highest mutagenic sensitivity is not found in the most immature spermatids, but in the relatively late stage sampled in the third week from irradiation. Before and after this peak the sensitivity is almost constant, being about half that of the peak. The incidence of dominant lethals among implantations alone is 35 per cent at the peak sensitivity and averages 20 per cent over the rest of spermiogenesis. The control value is 4 per cent. Assuming all these failed implants to be genetic in origin, we obtain as an estimate of the 'doubling dose', 50 r. (for the less-sensitive stages), which is the same as that calculated by Russell[8] for mutation in spermatogonia, and given extra weight by being cited in the recent White Paper on radiation hazards to man[9].

The data will be presented more fully and discussed more intensively elsewhere.


[1] Bateman, A. J., *Nature*, **177**, 934 (1956).
[2] Auerbach, C., and Slizynski, B. M., *Nature*, **177**, 376 (1956).
[3] Russell, W. L., Russell, Liane B., and Kimball, A. W., *Amer. Naturalist*, **88**, 269 (1954).
[4] Bateman, A. J., *J. Genet.* (In the press).
[5] Hertwig, P., *Biol. Zentr.*, **58**, 273 (1938).
[6] Auerbach, C., *Z. indukt. Abstamm.- und Vererb.-Lehre*, **86**, 113 (1954).
[7] Baker, W. K., and von Halle, E. S., *Proc. U.S. Nat. Acad. Sci.*, **39**, 152 (1953).
[8] Russell, W. L., *Cold Spring Harbor Symp. Quant. Biol.*, **16**, 327 (1952).
[9] Waddington, C. H., and Carter, T. C., "Hazards to Man of Nuclear and Allied Radiation", Cmd. 9780, Appendix H, 103 (1956).


# A DISTURBING FACTOR IN VERY HIGH FREQUENCY COMMUNICATIONS VIA IONOSPHERIC FORWARD SCATTER


By D. A. CROW and F. A. KITCHEN

Royal Naval Scientific Service, London

AND

G. A. ISTED and G. MILLINGTON

Marconi Research Laboratories, Great Baddow, Essex


IT is now well known that it is possible to communicate over long distances at very high frequencies by forward scatter from ionospheric turbulence[1–3]. Since the latter part of 1955, an elusive but persistent trouble has been experienced on an experimental scatter communications link from Gibraltar to the United Kingdom, operating on 37·30 Mc./s. Difficulty was experienced when attempts were made to receive teleprinter signals at 50 bauds with frequency-shift keying. Initially, the difficulty was evidently largely due to keying equipment faults, and the whole effect seemed to be greatly enhanced when the frequency deviation was increased from 2000 c./s. to 4800 c./s. in January. The effect manifested itself as a lack of purity in the note of the heterodyned signal, combined with a beat tone of the same order as the frequency deviation, and resulted in complete inability to print teletype correctly. The fact that the effect often appeared and disappeared within a very few minutes, and frequently coincided with some alteration made to the transmitter, at first suggested equipment troubles. However, when these had been carefully eliminated, the effect remained.

At this stage, some long-delay multipath effects were suspected, and it was clearly desirable to pulse-

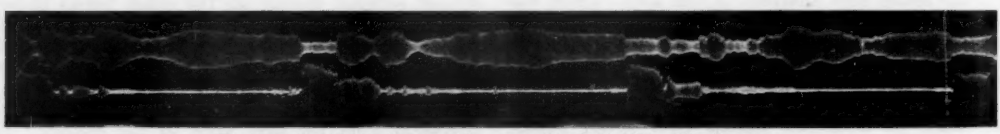


Fig. 1. 50-baud letter shift, 12.04 hr., G.M.T., March 14, 1956. Directive array

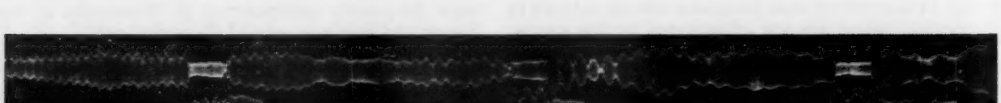


Fig. 2. 50-baud letter shift, 12.04 hr., G.M.T., March 14, 1956. Directive array

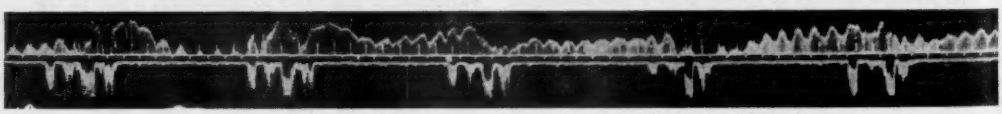


Fig. 3. 10-msec. pulse at *PRF* of 4 per sec., 11.10 hr., G.M.T., April 3, 1956. Directive array

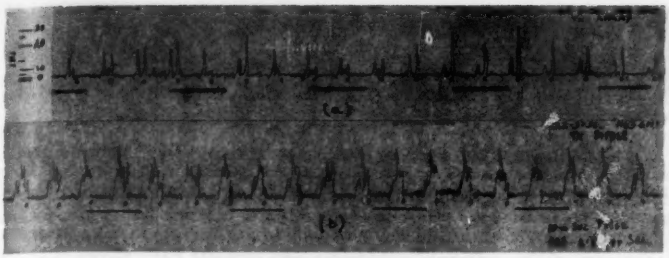


Fig. 4. High-speed amplitude recordings of the 'space' channel signal. (*a*) Directive array; (*b*) dipole

modulate the transmitter to determine their origin. Since this was not possible directly, an approach to pulse modulation was achieved by sending a sequence of teleprinter letter-shift signals, which consist of the start digit (20 ms space), followed by all mark including the stop digit (a total of 130 ms). By observing with a narrow-band receiver tuned to the space frequency, the effect of a pulse transmission was obtained with 20 ms pulses at 6⅔ pulses per sec. At once it was observed that discrete delayed signal components were present, at approximately 20 and 40 msec. delay relative to the direct forward scatter signal. Occasionally 60 and 80 msec. delay components were detected, and also possible traces of later components up to 130 msec. Figs. 1 and 2 show these effects as originally observed on a visual display of the receiver outputs. The outputs from both mark and space channels are shown, the upper trace being the mark signal. Fig. 2 illustrates a most interesting distinction between the direct forward-scatter component of the signal, which carries a Doppler amplitude modulation of variable phase, and the delayed signal components accompanying it, which have no such modulation. This suggested that the two signal components were being supported by different propagation mechanisms.

In order to obtain greater time discrimination between the delay components, and to disprove a suggestion that round-the-world echoes were involved, arrangements were made to reduce the pulse of space-frequency signal to 10 ms, while increasing that of the mark-frequency signal to about 200 ms. The result is shown in Fig. 3, where the separation of the components at discrete intervals of approximately 20 msec. is clearly seen. Timing marks at 20 ms intervals are shown on the mark signal trace. The film speed is slower than on the previous photographs, and this record is of the rectified audio output of the receiver. Fig. 4 shows a series of high-speed amplitude recordings made of the 'space' channel signal. That received from the transmitting array is shown in (*a*) and that from the transmitting dipole in (*b*). Both records were made within a space of half an hour and they are typical of propagation conditions existing in the morning during March. In each of the records the position of the direct signal component has been marked with a distinctive dot. Time advances from right to left, second intervals being indicated by the commencement of each black bar under the record. A calibration of relative amplitudes is included in Fig. 4(*a*).

The discrete nature of delayed signal components is well illustrated in each record, but it should be noted that in the dipole transmissions the direct signal component often disappears into noise. Further typical results obtained when transmissions were made on a horizontal dipole, instead of the normal directive array, are shown in Fig. 5. The direct component of the received signal is again of relatively small amplitude, whereas that of the delayed component is somewhat greater than that normally experienced using the array. This indicates quite clearly that the dipole radiation to the *rear* of the direct path is responsible for the enhancement in the amplitude of the delayed signal components. The appearance of the gap on the mark trace at the instant of the delayed signal component, rather than at the instant of the direct component, is to be expected under these conditions.

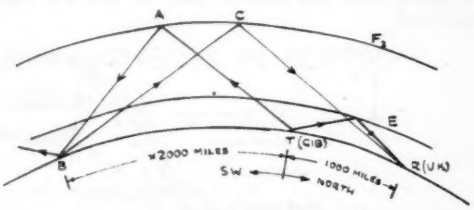



Fig. 6. Elevation of scatter signal paths

An earlier investigation[4] had predicted that long-distance propagation of frequencies up to 50–55 Mc./s. due to normal *F*-region reflexion could be expected around mid-day in the months of seasonally high *F*-region ionization densities between the autumnal and vernal equinoxes, in years near the solar cycle maximum, thereby causing mutual interference between remotely situated, short-distance VHF services. Moreover, it has long been known that, under these conditions, scattered signals can be reflected back by the *F*2-region towards the transmitter[5]. At the time of the present observations, it was known from predicted data that the sunspot activity was rising very rapidly towards a high maximum, expected in 1957, and the other parameters were favourable to this mode of propagation coming into play for 37 Mc./s. at low latitudes, at least for certain daylight hours.

Consideration of available data on the *F*-region characteristics of the ionosphere led to the suggestion that, for several daylight hours, back radiation from the Gibraltar transmitting aerial was being propagated via this region to an area south of Gibraltar and

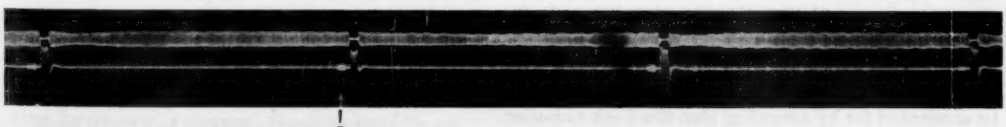


Fig. 5. 10-msec. pulse at *PRF* of 4 per sec., 15.35 hr., G.M.T., March 20, 1956. Reference dipole

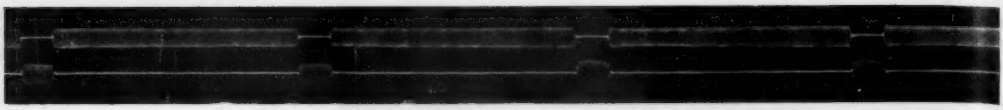


Fig. 7. 50-baud letter shift, 20.25 hr., G.M.T., March 14, 1956. Directive array

scattered back by the ground or sea, the components of the scattered signal being re-transmitted via the *F*-region direct to the United Kingdom.

Such a process is illustrated in Fig. 6. The back radiation makes one hop via the *F*2 layer to an area approximately 2,000 statute miles to the rear of the Gibraltar aerial at *B*, where it is scattered back from the Earth's surface towards the United Kingdom by a single hop of 2,500 miles. The total difference of path-length between this path and the direct Gibraltar/United Kingdom path, allowing for the curvature of the Earth, the influence of the troposphere and the heights of the lower *E* and the *F*2 layers, is sufficient to give the observed delay of about 20 msec. on the earliest delayed component to arrive. An important point in this explanation is that the *F*2 reflexion point *A* for the backward hop was in a lower latitude than that of the corresponding point *C* for the forward hop. Thus, the higher ionization density at point *A* was able to support the higher-angle radiation required over the shorter path in the *F*2 region involved.

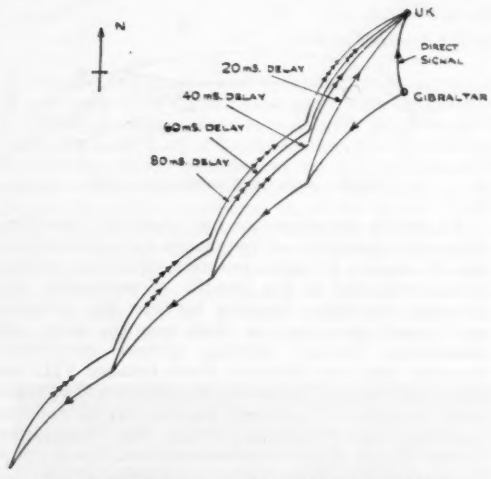



Fig. 8. Schematic plan of multi-hop delayed signal paths

It was at once confirmed that the effect was confined to daylight hours, showing a steady increase from its first occurrence at about 1000 G.M.T. to a maximum around 1600, and disappearing again quite sharply at about 1900. Fig. 7 shows the clear reception obtained later in the evening, which confirmed that the effect was not due to faulty transmitter keying. Afterwards, during the *S.I.D.* observed at 1620 G.M.T. on March 15, the delayed components disappeared completely for the duration of the disturbance, confirming that they are returned by *F*-region reflexion.

While the above explanation might serve for the first delay component, the later components could be accounted for by assuming that the back radiation from the transmitting aerial made two or more hops before being back-scattered and then returned to the receiver in the United Kingdom by similar hops (see Fig. 8). Each additional hop in this case would probably be of the order of 1,750 miles, to give a total additional delay of multiples of about 20 msec. Direction-finding measurements have shown that the delay components arrive from the south-west. This is in accord with measurements of the azimuthal radiation pattern of the Gibraltar transmitting aerial (Fig. 9), which shows that the back lobe of radiation is distorted to the westward by the upper flanking surface of the Rock. Radiation to the south-east is prevented by the upper mass of the Rock itself. The radiation in a south-westerly direction is sufficiently strong to support an 80 msec. delayed signal, as shown schematically in Fig. 8. It appears that such a delayed signal component could only be supported in this direction from Gibraltar, because of the distribution of *F*-region ionization density. In the absence of the Rock, the whole sector between the south-east and south-west directions from the transmitting site would be a potential source of delayed signal components. However, the discrete nature of the various delay components normally observed requires further investigation.

Support for this explanation of the delayed signal components experienced on 37 Mc./s. is available in that 45 Mc./s. television signals from the United Kingdom were being received concurrently in South Africa.

While it is clearly necessary to pursue this investigation further to confirm the identity of the mechanism by which these long-delayed multipath signals arise in VHF propagation in the lower latitudes, sufficient evidence is available to show that the

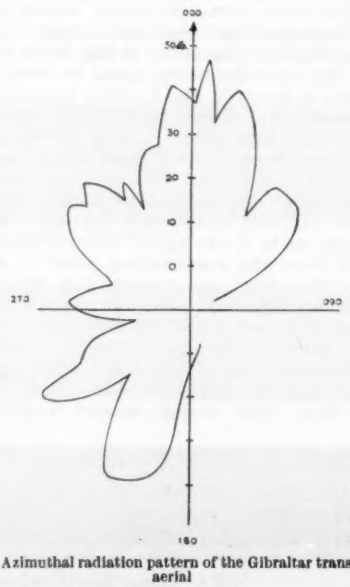



Fig. 9. Azimuthal radiation pattern of the Gibraltar transmitting aerial

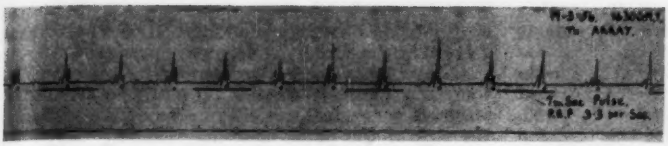


Fig. 10. High-speed amplitude recording during the late afternoon. Directive array

effect which these will have on operational automatic telegraphy circuits using VHF forward-scatter propagation in these areas may be disastrous. This is emphasized by Fig. 10, a typical record made of the array transmission in the late afternoon when the level of the direct signal component is low and that of the back-scattered component is normally high. Thus, from this record it can be seen that, in spite of the back-to-front protection of the array, the back-scattered component can be as much as 20 db. greater in amplitude than the direct forward-scatter component. This implies that, in order to achieve a safe 10db. signal/interference ratio, the present back-to-front ratio of the array must be improved by 30 db. While substantial improvement can doubtless be achieved by use of transmitting aerials of higher back-to-front ratio, allowance will have to be made for these effects and operational frequencies may have to be increased to values greater than 50 Mc./s. for periods near sunspot maximum[4]. The present effects are likely to continue for a few years, and may even be experienced under summer conditions on the present operating frequency.

The results described were obtained as part of a joint programme of research sponsored by the Admiralty and the Marconi Research Laboratories. Thanks are due to both these authorities for facilities granted in the conduct of the work, and for permission to publish this article.

[1] Bailey, D. K., *et al.*, *Phys. Rev.*, **86**, 141 (1952).
[2] Bailey, D. K., Bateman, R., and Kirby, R. C., *Proc. Inst. Rad. Eng.*, **43**, 1181 (1955).
[3] Bray, W. J., *et al.*, *Proc. Inst. Elect. Eng.*, **103**, Part B, No. 8, 236 (1956).
[4] Kitchen, F. A., and Tremellen, K. W., *Proc. Inst. Elect. Eng.*, **99** Part III A, 290 (1952).
[5] Eckersley, T. L., *J. Inst. Elect. Eng.*, **71**, 405 (1932).

---

# DISTRIBUTION OF ANTHOCYANIN PIGMENTS IN POPPIES

By Dr. R. M. ACHESON
Department of Biochemistry
AND
Dr. JOHN L. HARPER and I. H. McNAUGHTON
Department of Agriculture, University of Oxford

IN the course of a comparative study of the biology of the cornfield poppies, *Papaver rhoeas*, *P. dubium*, *P. lecoqii*, *P. argemone* and *P. hybridum*, it was considered of interest to determine whether the slight differences in petal colour found in this group were due to qualitative differences in anthocyanin and, if so, whether the differences might be of taxonomic value.

On morphological grounds, *P. argemone* and *P. hybridum* constitute a distinct group possessing spines on the capsules and more dissected leaves than the smooth-capsuled species, *P. rhoeas*, *P. dubium* and *P. lecoqii*. The stamens of the former group possess laterally expanded, club-shaped filaments in contrast to the fine thread-like filaments of the latter species. Specimens labelled *P. hybridum* from several botanic gardens were markedly different from field collections of this species. Flowers were larger, were orange pink instead of the characteristic crimson of *P. hybridum*, and the degree of spine development on the capsule and the general growth habit were quite different. In the subsequent discussion this material is described as *Papaver* β pending further taxonomic investigation. Flower samples were collected from plants grown both in a greenhouse and in the field: the original seed samples were collected in the field or obtained from botanic gardens. Most of the species show a range of petal colour, and so, where possible, the extreme colour forms were examined for each species.

Anthocyanins were extracted by moistening the plant material with 0·1 per cent hydrochloric acid. Several species possess a characteristic black spot at the base of the petals and the pigments from the top and the base of the petals were therefore extracted separately.

Cyanidin and pelargonidin derivatives have previously been detected in the flowers of a number of *Papaver* species by colour and distribution reactions[1], and in the case of *P. rhoeas* two pigments were isolated[2]. Detailed studies have been made of the genetics of flower colour in *P. rhoeas*, especially in the cultivated Shirley poppy[3]. Chromatographic methods recently developed[4] permit an easier and more accurate characterization of the anthocyanins than the distribution reactions and have been applied to the flowers of the five *Papaver* species already listed above. Ascending chromatograms on Whatman No. 1 paper with *n*-butanol / acetic acid / water (40 : 10 : 50 by volume) at 22·5° C. gave better separation than when a descending solvent was used. The $R_P$ values obtained were occasionally somewhat variable and so a minimum of four determinations was made on each flower extract. Synthetic fragasin (pelargonidin-3-galactoside, $R_F$ 0·51), callistephin (pelargonidin-3-glucoside, $R_F$ 0·55) or chrysanthemin (cyanidin-3-glucoside, $R_F$ 0·35) were used as standards on every chromatogram, and the $R_F$ values agreed with values already published[4] for the last two compounds (0·59 and 0·33).

Hydrolysis of the anthocyanins to the anthocyanidins and identification of the latter by colour reactions was undertaken and chromatographic comparisons were made with synthetic pelargonidin ($R_F$ 0·70) and cyanidin ($R_F$ 0·50) in the Forestal solvent[5]; Bate-Smith[6] gives $R_F$ 0·68 and 0·50, respectively. Our results confirm and extend earlier less-detailed conclusions regarding both the anthocyanin content and distribution in *P. rhoeas* and *P argemone*, the only poppies of the *rhoeas* group which have been investigated from this aspect before.

Six distinct anthocyanins have been found in the poppies which we have examined, three cyanidin derivatives (*A*, *B* and *C*) and three pelargonidin derivatives (*A*, *B* and *C*). The species differ strikingly both in kind and distribution of these pigments (Fig. 1).

The petals of the morphologically similar species, *P. rhoeas*, *P. dubium* and *P. lecoqii*, contain only two anthocyanins, cyanidin *B* and pelargonidin *C*. The pelargonidin derivative is absent from the anthers where cyanidin *B* is present, and cyanidin *B* is abundant in the bases of the petals and absent from the tips (except in *P. rhoeas*, where it is present in lower concentration). No qualitative differences were detected between any of the colour variants of these species collected from the wild, but a specimen of the Shirley poppy lacked pelargonidin derivatives. A Shirley poppy examined by Robinson[1] lacked cyanidin derivatives. Scott-Moncrieff[3] has shown that the development of cyanidin and pelargonidin pigmentation in the Shirley poppy is genetically controlled and provides a biochemical interpretation of the results obtained by Newton and by Philp[3] in breeding experiments. Our results confirm those of Scott-Moncrieff in finding only one cyanidin derivative in *P. rhoeas*, whereas Schmidt and Huber[2] stated that a second cyanidin derivative was present.

*Papaver argemone* generally resembles *P. rhoeas* in the distribution of cyanidin *B* and pelargonidin *C*, although concentrations of cyanidin appear higher in the tips of the petals and the stamens. However, two additional anthocyanins are present in this species, a slow-moving cyanidin derivative (*A*) and a slow-moving pelargonidin derivative (*B*), both of which are in greatest concentration in the tips of the petals. No qualitative differences could be found between the pigments of orange and deep red forms of this species, but the amount of pelargonidin was less in the red form.

*Papaver hybridum* lacked all pelargonidin derivatives: cyanidin *A* was present in low concentrations in petal bases, where it was associated with the highest concentration of cyanidin *B*. In the tips of the petals a fast-moving anthocyanin (cyanidin *C*) was present. The botanic garden specimens β also contained all three cyanidin derivatives, but in addition three pelargonidin derivatives were present, the slow-moving pelargonidin *A* characteristic of *P. argemone*, the common pigment *C*, and in addition a further unknown anthocyanin, intermediate in $R_F$ value between *A* and *C*, but giving a quite distinct spot. (A spot in this position was obtained from one sample of *P. dubium*, but was not found in any other samples.) Cyanidin *B* and *C* were also found in the old leaves of *Papaver* β. No other species developed pigments in the leaves.

No attempt has been made to identify the anthocyanins accurately, but it is worth noting that cyanidin *A* and cyanin (cyanidin-3 : 5-di-glucoside, $R_F$ 0·16 [4]) and cyanidin *B* and chrysanthemin may be identical. Chromatographic identity of the pigments obtained from different species was shown by chromatography of mixed samples and the constituents on the same paper.

It is evident that the characteristic grouping of the anthocyanin pigments in different species supports groupings of the five species which might be made on morphological grounds. It can be seen that studies of the characteristics of petal pigments, even of species with rather similar coloration, may prove of taxonomic value; in this case the analysis of anthocyanins adds strong support to the original supposition that *P. hybridum* and the form β are distinct. In this connexion it may be noted that biochemical investigation has proved valuable in establishing relationships in the genus *Senecio*, where characteristic alkaloids of the necic acids are of taxonomic value[6].

Attempts are being made to synthesize hybrids of all the cited species, and, where possible, examination will be made of the anthocyanins present in $F_1$ and $F_2$ material.

The study of the biology of the poppies is being supported by a grant from the Nature Conservancy to the Department of Agriculture.

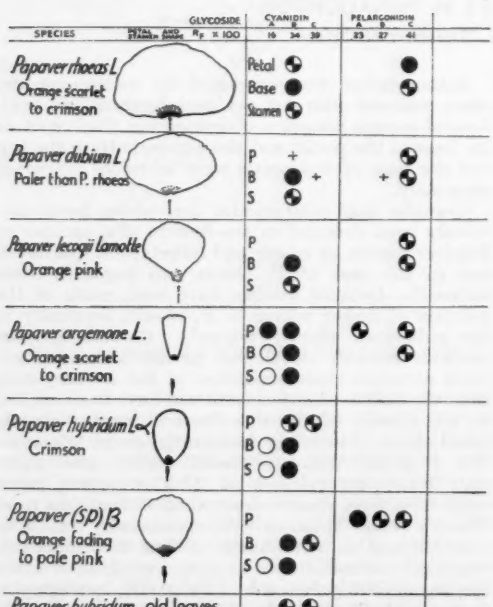



Fig. 1. $R_F$ values of anthocyanin derivatives from the petals, stamens and leaves of *Papaver* spp. (*rhoeas* group). Typical petal and stamen shapes are illustrated, but the size of these organs and extent of the basal spot are very variable

●, Well-defined, relatively very intense spot; ◔, well-defined spot; ○, diffuse spot; +, found in only one specimen (see text)

[1] Robinson, G. M., and Robinson, R., *Biochem. J.*, **25**, 1687 (1931); **26**, 1647 (1932). Lawrence, W. J. C., Price, J. R., Robinson, G. M., and Robinson, R., *ibid.*, **32**, 1661 (1938); *Phil. Trans.*, **230** B, 149 (1939).

[2] Schmidt, L., and Huber, R., *S.B. Akad. Wiss. Wien*, IIb, **139**, 1049 (1930); **141**, 205 (1932). Schmidt, L., and Körnperth, H., *ibid.*, **146**, 510 (1936).

[3] Newton, W. C. F., *J. Genet.*, **21**, 389 (1929). Philp, J., *ibid.*, **28**, 175 (1933). Scott-Moncrieff, R., *ibid.*, **32**, 117 (1936).

[4] Bate-Smith, E. C., Biochem. Soc. Symposia No. 3, 62 (1949).

[5] Bate-Smith, E. C., *Biochem. J.*, **58**, 122 (1954).

[6] Manske, R. H. F., Bull. Imp. Bur. Past. and For. Crops (Herb. Publ. Ser.), **27**, 27 (1940).

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## The Cones of the Grass Snake's Eye

In the course of an investigation of the photosensitive pigments of the grass snake retina, photomicrographs were taken of fresh flat retinal preparations. The retina was carefully removed from a newly killed animal and mounted in a drop of saline confined within a shallow wax ring on a coverglass with the outer retinal surface in contact with the glass. The whole was then inverted on to a slide[1] and examined under the microscope. In such a preparation the light passes across the retina in the same direction as it does in the living eye, that is, from the internal to the external limiting membrane, and then along the visual cells parallel to their long axes. What one looks at down the microscope is a cross-section of the visual cells.

All the visual cells of the retina of the grass snake (*Tropidonotus natrix natrix*) are cones (Fig. 1). These cones are a little unusual in the relative sizes of their inner and outer limbs. The outer limb of a cone is always more slender than the inner limb (unlike the rods, where the thicknesses of the two parts tend to be much more nearly equal) but the disproportion in the grass snake is markedly greater than is common.

When the fresh cones were viewed end on, as in the preparation described above, it was noticed that they appeared very bright when the microscope was focused on the outer limbs; but when the focus was moved down on to the inner limbs these appeared dark (Fig. 2). At the same time the cross-section of the cones increased very much. Photomicrographs were taken in monochromatic light, and the density of different parts of the preparation measured by means of a microdensitometer.

We found that at 578 and 640 mμ the intrinsic brightness of the light emerging from the tips of the outer limbs of the cones was greater than that transmitted through the plain glass of the slide and coverslip with the saline layer but no retinal tissue between. At shorter wave-lengths (436 and 546 mμ) there was some loss on passage through the retina and cone, but the tip of the outer limb still appeared intrinsically brighter than the surround.

This result can only mean that in some way light is condensed on passing through a cone on a path parallel to its axis or nearly so. The simplest way in which this could be accomplished would be if there were total internal reflexion within the cone, so that all the light which enters by the broad base of its inner limb on the internal limiting membrane is directed into the narrow tip of its outer limb. The idea of total internal reflexion of rays parallel to their axes within human cones has been put forward by Wright and Nelson[2] and elaborated by O'Brien[3] as a result of experiments with models. Such reflexion would prevent spreading of light after it is brought to a focus in the inner limb and might also explain the Stiles–Crawford effect. In addition, it would increase the absorption by pigment in the outer limbs of the cones. There are, of course, other possible explanations of the phenomenon described here, but in the absence from the grass-snake cone of any structure (except the inner limb as a whole) such as a paraboloid or oil droplet which might act as a condensing

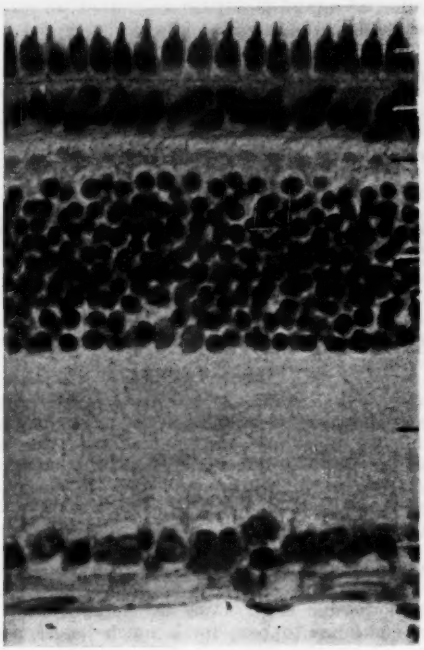



Fig. 1. Section through the pure-cone retina of the grass snake. (1) Cones; (2) outer nuclear layer; (3) outer fibre layer; (4) inner nuclear layer; (5) inner fibre layer; (6) ganglion cells. Kolmer's fixative; Mallory's phosphotungstic acid hæmatoxylin. × 440

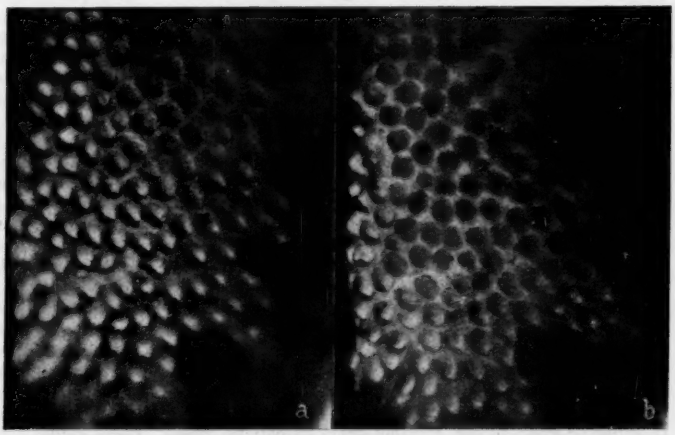



Fig. 2. Fresh snake cones. Two photomicrographs of the same field: (*a*) focused as far as possible on to the outer limbs; (*b*) at a lower focus. The cone marked × shows the bright outer limb in *a* and the larger, darker, inner limb in *b*. × 300. Photographed in 436 mμ light

lens, that of total internal reflexion seems to provide a reasonable preliminary hypothesis.

K. Tansley

Institute of Ophthalmology,
London, W.C.1.

B. K. Johnson

Imperial College of Science and Technology,
London, S.W.7.

Sept. 28.

[1] Denton, E. J., and Pirenne, M. H., *J. Physiol.*, **116**, 33P (1952).
[2] Wright, W. D., and Nelson, J. H., *Proc. Phys. Soc.*, **48**, 401 (1936).
[3] O'Brien, B., *J. Opt. Soc. Amer.*, **41**, 882 (1951).

## Survival of the Heart following Deep Hypothermia

Deep hypothermia of warm-blooded animals favours the survival of their organs. For example, in the rat at normal body-temperature the heart ceases to beat several minutes after opening the chest, whereas in the rat cooled to 15° C. by the closed-vessel technique cardiac contractions can be seen approximately 1 hr. after respiratory arrest[1]. The intestine removed from a hypothermic dog contracts spontaneously when re-warmed and retains this property longer than an intestine isolated from a normothermic dog[2]. We have shown that the heart continues to beat for a much longer period after opening the thorax in rats which have been severely chilled and then re-warmed to normal body-temperature than in rats at the same temperature which had not been previously chilled[3].

The effect of profound hypothermia is shown equally well by survival of the heart after functional arrest. This is illustrated by the experiments to be described here.

When rats at normal body-temperature are killed by destroying the medulla and opening the chest, their hearts cease to beat after several minutes. If the bodies are then placed in the refrigerator at 6–9° C., cardiac contractions can be induced 6–12 hr. later in about half the animals by pouring Ringer's solution at 38–40° C. directly on to their hearts. Even after 48 hr. this technique sometimes elicits weak signs of activity around the orifices of the great veins.

Much more striking results are obtained if the rats are in a state of deep hypothermia when killed. Rats cooled by the closed-vessel technique[4] to body-temperatures between 13° and 16° C. were killed as described above and put with open thoraces in the refrigerator at 6–9° C. At this temperature the heart soon stops beating. Next day and on subsequent days the hearts are re-warmed by pouring over them Ringer's solution at 38–40° C. As a result, ventricular contractions are frequently seen several days after death, while rhythmic movements near the openings of the great veins have actually been seen when the corpses had been kept at 6–9° C. for as long as eighteen days.

Re-warming the heart for several moments daily by our method seems to prolong the functional survival which we have just described. We also noticed that this phenomenon is more regularly seen in exsanguinated hearts.

It is known that, in rats cooled to the point of freezing or even below, cardiac activity can be completely re-established approximately one hour after cessation of breathing and circulation[5]. Certain manifestations of myocardial activity can, as we have just seen, be observed many days after death provided that the rat was killed in deep hypothermia and the corpse stored at a low temperature.

The point is not, of course, that there is a genuine re-establishment of the functions of the heart, but only that there are a few signs of activity of the myocardium. Our results nevertheless indicate that deep hypothermia before death is favourable for survival of the myocardium. It might also be an advantage when transplanting or culturing organs and tissues from homœotherms to remove them from animals in deep hypothermia.

J. Giaja
J. Radulović

Institut de Physiologie de la Faculté des Sciences,
Université de Belgrade.

[1] Giaja, J., Andjus, R. K., and Senberger, M., *C.R. Soc. Biol., Paris*, **146**, 1529 (1952).
[2] Montini, T., Rossi, O., and Dacha, U., *Archivio Maragliano*, **10**, 421 (1955).
[3] Giaja, J., and Radulović, J., *C.R. Acad. Sci., Paris*, **242**, 2039 (1956).
[4] Giaja, J., *Bulletin de l'Academie Royale Serbe*. Sciences Mathématiques et Naturelles, B, **6**, 65 (1940); *C.R. Acad. Sci., Paris*, **210**, 80 (1940).
[5] Andjus, R. K., *Srpska akademija nauka. Glas*, **200**, 249 (1951); *C.R. Acad. Sci., Paris*, **232**, 1591 (1951); *J. Physiol.*, **128**, 547 (1955). Andjus, R. K., and Lovelock, J. E., *J. Physiol.*, **128**, 541 (1955). Andjus, R. K., and Smith, A. U., *J. Physiol.*, **128**, 446 (1955). Goldzveig, S. A., and Smith, A. U., *J. Physiol.*, **132**, 406 (1956).

## Effect of Surface-active Agents on the Living Cell

It was observed some time ago[1] that treatment with surface-active agents influences the freshness and the keeping qualities of picked fruit and the development of cut flowers. When freshly picked fruit were sprayed with a dilute (0·01–0·1 per cent) solution of a surface-active substance the fruit kept about twice as long as the controls. It has also been demonstrated that similarly treated buds of freshly picked flowers can be forced to open prematurely.

Experiments have been carried out on the action of such compounds on living plants. Undiluted non-ionic surface-active agents were used, as earlier investigations seem to indicate that little effect can be obtained with dilute solutions.

Twelve bare twigs on a shrub of mock orange (*Philadelphus coronarius*) were painted with 'Tween 40' (polyoxyethylene sorbitan-mono-palmitate) at the beginning of August; on six of the twigs the treatment was repeated twice at intervals of one week. On the twigs which had been treated only once, the first green buds appeared six weeks later, 12–14 days before they did on any of the untreated branches. The twigs which had been treated three times remained bare throughout the summer.

On a red flowering rosebush three small rosebuds were painted with 'Triton *X* 100' (alkylated aryl poly-ether alcohol). Three days later the buds started to open, although they were only half the size of the buds which open under normal conditions. The flowers were distorted; their petals nearly colourless. This distortion was also observed when the experiment was repeated using other surface-active substances.

Four *Hibiscus* buds were painted with *G* 8916-*P* (polyoxyethylene-sorbitan esters of mixed fatty and resin acids). The buds started to open two days after the treatment, five days before the control buds which were at the same stage of development. In

another experiment a branch of a *Hibiscus* shrub carrying several flower-buds was painted with 'Span 80' (sorbitan-mono-oleate). The effect of this substance could be observed for three weeks; all the flowers were slightly distorted.

Six *Hydrangea* twigs were painted with 'Triton X 100' at the end of winter and the treatment was repeated, after an interval of four weeks. On all the treated twigs axillary buds appeared first, 6–7 weeks before their appearance on the untreated branches.

Kurssanow[2] assumed that the enzymes in the plant cell synthesize or hydrolyse according to whether they are adsorbed or free. In recent years Veldstra[3] and Wain[4] have tried to correlate the structure and the surface-activity of different hormones with their physiological activity. We are attempting to show the action of surface-active compounds on animal cells. Such compounds of dissimilar constitution are very similar in action to plant-hormones; in further experiments on plants we hope to determine whether these compounds have themselves growth-regulating properties or whether they only stimulate the cells to produce growth-regulating substances.

HELEN GOLDHAMMER

Department of Biological Sciences,
N.S.W. University of Technology,
Sydney.
Sept. 14.

[1] Aust. Patent No. 159,917.
[2] Kurssanow, A. L., "Adv. in Enzymol.", **1**, 329 (1941).
[3] Veldstra, *Biochim. Biophys. Acta*, **1** (1947); **3** (1949).
[4] Wain, "Plant Growth Substances" (1953).

## Serum Protein Differences between Africans and Caucasians

THE use of starch gels as a supporting matrix for electrophoresis was found by Smithies[1] to result in much greater resolution of the serum globulins than can be achieved by the other media thus far employed. On the basis of differences in the behaviour of the $\alpha_2$ globulins he was able to divide the Caucasians whom he studied into three qualitatively different groups and obtained evidence that these groups were the result of a Mendelian two-allele system showing no dominance, Types I and II*B* representing the two homozygotes and Type II*A* the heterozygote[2].

We recently have had an opportunity to examine a series of blood samples obtained from natives of Liberia and the Ivory Coast and find that the frequencies of the three types differ rather markedly in these samples from the frequencies thus far observed in Caucasians. The results are shown in Table 1. The values given for Caucasians were obtained by combining our unpublished data with those of Smithies[2], the two series being very similar. The difference between the two racial groups is highly significant. The frequency of the gene which when homozygous results in Type I can be calculated to be 0·42 in the Caucasians and 0·70 in the Africans. It thus appears that this trait may be of value in anthropological studies.

Table 1

| Type | No. of individuals of each serum type | | | |
|---|---|---|---|---|
| | I | II*A* | II*B* | Total |
| Caucasians | 16 | 54 | 33 | 103 |
| Africans | 69 | 60 | 13 | 142 |

$\chi^2 = 36{\cdot}77$. d.f. = 2

Although it has been possible to classify all the specimens thus far encountered with respect to the three Smithies types, there exist quantitative variations within the nominal types which raise the possibility that the genetic basis of these proteins may be more complex than originally postulated. However, the frequencies of the three types in the African sample agree unusually well with the assumption of equilibrium based on the genetic hypothesis of Smithies and Walker[3].

A second difference which has been discovered in the blood samples from Africa is the existence of qualitative variations in the protein fraction designated by Smithies[2] as $S\alpha_2$. In all these samples, this fraction migrates faster than the corresponding fraction of Caucasians, very nearly coinciding in hæmoglobin-complexed specimens with the slowest moving of the three bands which characterize II*A* individuals. This may lead to some difficulty in identifying the Smithies fractions. The significance of this additional variation, which may also be under genetic control, is being studied.

H. ELDON SUTTON
JAMES V. NEEL

Department of Human Genetics,
University of Michigan,
Ann Arbor, Michigan.

G. BINSON

Institut d'Hygiène de la Côte d'Ivoire,
Abidjan, Afrique Occidentale Française.

WOLF W. ZUELZER

Child Research Center of Michigan,
Detroit, Michigan.
Sept. 17.

[1] Smithies, O., *Nature*, **175**, 307 (1955).
[2] Smithies, O., and Walker, N. F., *Nature*, **176**, 1265 (1955).
[3] Smithies, O., *Biochem. J.*, **61**, 629 (1955).

## Reversible Degradation of Adenosine Triphosphate to Inosinic Acid during a Single Muscle Twitch

IN a muscle which performs mechanical work, adenosine triphosphate is degraded to inosinic acid. During aerobic rest, adenosine triphosphate is resynthesized from inosinic acid and creatine phosphate[1]. We have succeeded in demonstrating qualitatively that the same holds true in a single muscle twitch.

Isolated fibres from the frog's semi-tendinosus muscle were stretched perpendicular to a monochromatic ultra-violet beam. The light intensity was measured with a photomultiplier and the changes in photoelectric current recorded on a cathode-ray oscilloscope. (Fig. 1: lower curves; a positive deflexion means an increase in light intensity). The tension of the fibre, as measured by a transducer, was recorded on the same oscilloscope screen (Fig. 1: upper curves), both beams being triggered by the stimulating pulse.

In the experiment illustrated in Fig. 1, there is a drop in light transmittance during the twitch at all wave-lengths from 546 to 240 mμ. In this experiment, scattered light has been excluded by the schlieren method. Any sudden rise in the scattering power of the muscle fibre would exert, in our condi-

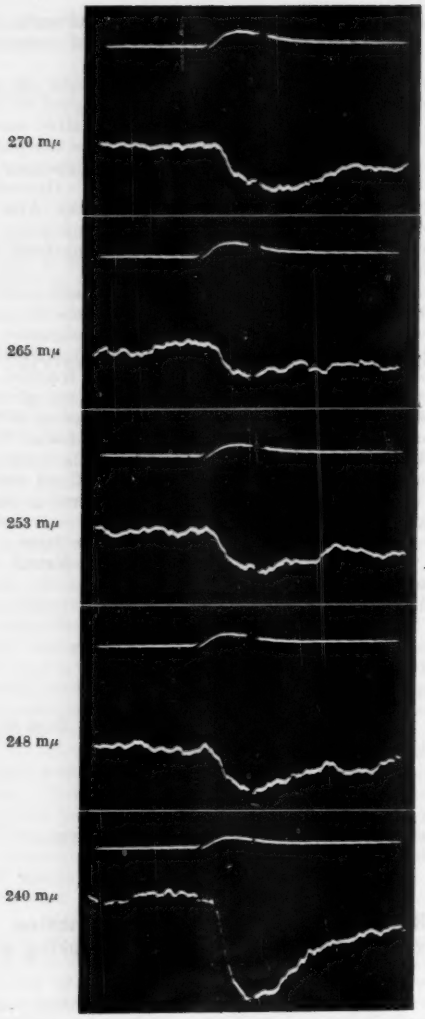



Fig. 1

tions, precisely the same unspecific effect on the total transmitted light: such a rise in scattering has been described for visible light[2].

At 265 mμ the drop in transmittance is markedly smaller than at 270 mμ or at 253 mμ, which means that an antagonistic effect, which cannot be other than a decrease in absorption, is superimposed on the scattering effect.

At 240 mμ the drop in transmittance is markedly larger, which shows that here an increase in absorption occurs.

The decrease in absorption at 265 mμ, the increase in absorption at 240 mμ, and no change at 248 mμ have been generally accepted since Kalckar's work[3] as a sign that adenine compounds are being deaminated to hypoxanthine compounds. The work reviewed above and the present material leave little doubt that what we have observed is in fact a reversible dephosphorylation–deamination of adenosine triphosphate during a single twitch.

We gratefully acknowledge the encouragement of Prof. A. von Muralt and Dr. S. Weidmann.

(the late) J. Wajzer
Rolf Weber*
Theodor Kocher Institut,
Bern.

J. Lerique
Hôpital des Enfants-Malades,
Paris.

J. Nekhorocheff
Physiologisches Institut,
Bern,
and
Institut de Biologie,
Paris.

* Present address: Organisch-chemisches Institut, Basel.

[1] Parnas, J. K., *Biochem. Z.*, **206**, 16 (1929). Wajzer, J., and Nekhorocheff, J., *Arch. Sci. Biol.*, **6**, 233, 275, 285 (1952). Lange, G., *Biochem. Z.*, **326**, 172 (1955). Nekhorocheff, J., *C.R. Acad. Sci., Paris*, **240**, 2088 (1955).

[2] Buchthal, F., Knappeis, G. G., and Sjöstrand, T., *Sk. Arch. f. Physiol.*, **82**, 225 (1939). Hill, D. K., *J. Physiol.*, **108**, 292 (1949); **119**, 501 (1953).

[3] Kalckar, H. M., *J. Biol. Chem.*, **167**, 445 (1947).

## A Complement-fixation Reaction with *Haemobartonella muris* and *Eperythrozoon coccoides*

Hitherto no serological reactions were known in *Haemobartonella* and *Eperythrozoon* animal infections. In the present study, antigens of *H. muris* and *E. coccoides* have been prepared from heavily infected blood cells of splenectomized rats and mice respectively. The blood was hæmolysed by 0·01 *M* citrate buffer (*p*H 6), washed three times by centrifugation (10 min. at 4,500 r.p.m.) and resuspended in veronal-buffered saline[1]. In the case of *E. coccoides* a further antigen containing the free organisms could be prepared by spinning the plasma fraction at 6,000 *g* and using the sediment. The frozen antigens could be stored for a long period without appreciable loss of activity. Immune sera were obtained either from splenectomized rats and mice after recovery from infection or from normal animals 3–5 weeks after intraperitoneal inoculation of parasitized blood. Normal sera were obtained from animals of parasite-free breeds.

The micro-method of complement-fixation[2] was used throughout the experiments. This technique proved to be very advantageous, as often only small quantities of sera or antigens were available. A series of complement solutions, diluted by the factor 1·6, was always used. By this means the anticomplementary activities of antigens and sera could be taken into account. The titres were expressed in logarithms of fixed complement units, the 50 per cent hæmolysis being used as the end-point. Antigens prepared from parasite-free blood did not react. Normal sera showed a weak reaction with some antigen preparations only. The specificity of the reaction could thus be established. Two- and three-dimensional tests revealed a similar relationship between antigen, antibody, and complement as can be found in other complement-fixing systems.

The time-course of antibody formation against *H. muris* was followed by testing sera taken repeatedly from individual rats. In non-splenectomized *bartonella*-free rats antibodies arise about five days after infection. The climax is reached after 3–5 weeks

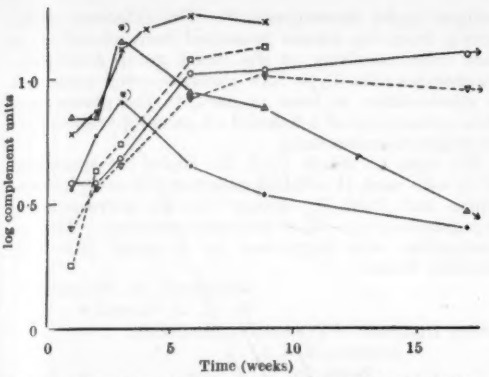



Fig. 1. Formation of antibodies after intraperitoneal infection with *H. muris* in non-splenectomized rats. 6 mgm. of neoarsphenamine at points marked •

(Fig. 1). Later on, the antibody-level remains constant for a long time. The latent infection of rats naturally infected with *H. muris* could thus be recognized by demonstrating complement-fixing antibodies in the sera. After treatment of the infection with neoarsphenamine the antibodies may gradually decrease (Fig. 1). The antibody-level of animals with latent infection diminishes after removal of the spleen, and the decrease is associated with an increase in the intensity of blood infection. The same occurs during relapses, when the parasite number increases (an example is shown in Fig. 2). The nature of this relationship between the undulations of the parasite number and the complement-fixing antibodies is uncertain. Neutralizing antibodies, which could conceivably account for the course of relapses, could not be demonstrated in any phase of the infection[3].

Different strains of *H. muris* showed no qualitative or quantitative antigenic differences in cross-fixation experiments. Furthermore, a unilateral cross-reaction between *H. muris* and *E. coccoides* could be demonstrated: *E. coccoides* immune sera reacted specifically with *H. muris* antigen; in the inverse case, however, no reaction occurred.

The complement-fixation reaction may be of practical use in the diagnosis of the carrier state in

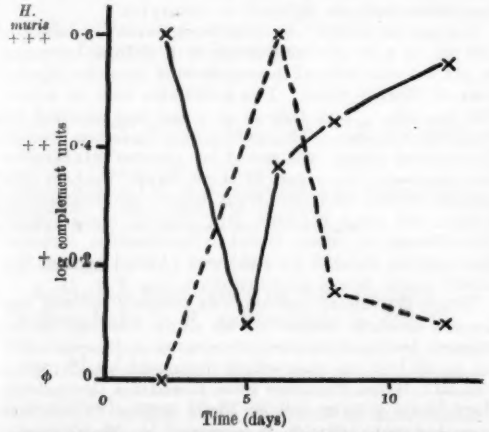



Fig. 2. Variation of complement-fixing antibodies during a relapse of *H. muris* infection. ———, Complement-fixation reaction; - - - -, parasite number

animal bartonelloses, as it has already proved to be in bovine anaplasmosis[4]. Moreover, it appears to offer a new method for the classification of animal bartonellas.

It should be mentioned that Marmorstone-Gottesman and Perla[5] as well as Lawkowicz[6] claimed to have demonstrated a complement-fixation reaction using cultured organisms from rat blood as antigens. The significance of these findings, however, is questionable, as the identity of the organisms with *H. muris* has not been proved.

Further results will be published in the *Zeitschrift für Tropenmedizin und Parasitologie*, and details of methods concerning the use and limitations of the micro-technique in the *Zeitschrift für Hygiene*.

R. WIGAND*

Virus Department,
Institute of Tropical Diseases,
Hamburg.
Sept. 17.

* Present address: Children's Hospital Research Foundation, University of Cincinnati, Ohio.

[1] Mayer, M. M., Osler, A. G., Bier, O. G., and Heidelberger, M., *J. Exp. Med.*, **84**, 535 (1946).
[2] Fulton, F., and Dumbell, K. R., *J. Gen. Microbiol.*, **3**, 97 (1949).
[3] Wigand, R., *Z. Tropenmed.* (in the press).
[4] Price, K. E., Poelma, L. J., Hastings, J. W., and Mitchell, J. I., 57th Ann. Proc. U.S.A. Livestock San. Assoc., 89 (Sept. 1953).
[5] Marmorstone-Gottesman, J., and Perla, D., *J. Exp. Med.*, **56**, 763 (1932).
[6] Lawkowicz, W., *Bull. Off. Internat. Hyg. Pub.* (Paris), **30**, 1781 (1938).

## Role of a D-glucosamine as Inhibitor of the Precipitation of Blood Group Substances by Anti-Type XIV Pneumococcus Serum

Beeson and Goebel[1] followed up earlier observations that human erythrocytes are agglutinated by Type XIV anti-pneumococcus horse serum[2] with the demonstration that blood group *A* substance obtained from commercial pepsin precipitated with the Type XIV antiserum. Subsequent studies have shown that blood group substances isolated from hog gastric mucin, human saliva and human stomachs by peptic digestion cross-react with anti-Type XIV serum[3]. Human blood group A, B or H substances isolated from ovarian cyst fluids by the phenol extraction method[4] do not precipitate to any appreciable extent in this system; but a strong cross-reactivity is developed after mild hydrolysis with acid[5] or by treatment with specific enzymes[6].

The detailed structure of the Type XIV pneumococcus polysaccharide has not yet been fully elucidated; but it is generally believed that the chemical basis for the cross-reactivity of the blood group substances with anti-Type XIV serum lies in the presence of galactose and *N*-acetyl-D-glucosamine in both the Type XIV polysaccharide and the blood group specific mucopolysaccharides[7]. Examination of the infra-red absorption spectrum of the Type XIV polysaccharide has indicated the presence of predominantly β-linkages[8]. Recently, Heidelberger[9] studied the precipitation of Type XIV antibody by a number of gums containing galactose, and concluded that multiple recurrences of non-reducing galactose end-groups suffice to produce cross-reactivity, but that gums with very few such end-groups which contain a number of 1,3- and/or 1,6- and/or 1,3,6-

Table 1. Inhibition of Precipitation of Type XIV Pneumococcus Antiserum by Degraded Blood Group Substances

| Inhibiting substance | Dilution of inhibiting substance | | | |
|---|---|---|---|---|
| | 1 : 100 | 1 : 200 | 1 : 400 | 1 : 800 |
| D-Galactose | 1 | 2 | 3 | 3 |
| L-Galactose | 3 | 3 | 3 | 3 |
| α-Methyl-D-galactopyranoside | 1 | 2 | 3 | 3 |
| β-Methyl-D-galactopyranoside | 1 | 2 | 3 | 3 |
| β-Methyl-D-galactofuranoside | 3 | 3 | 3 | 3 |
| Melibiose | 1 | 2 | 3 | 3 |
| Lactose | 0 | 1 | 2 | 3 |
| O-β-D-Galactosyl-(1→3)-*N*-acetyl glucosamine | 1 | 2 | 2 | 3 |
| O-β-D-Galactosyl-(1→4)-*N*-acetyl glucosamine | 0 | 0 | 0 | 1 |
| O-β-D-Galactosyl-(1→6)-*N*-acetyl glucosamine | 1 | 2 | 2 | 3 |
| Control (Type XIV antiserum + blood group substance) | 3 | | | |

The inhibition tests were carried out using 0·1 ml. 1 : 1,000 conc. blood group substance, 0·1 ml. of inhibitor and 0·1 ml. horse antitype XIV pneumococcus serum. Degree of inhibition read after standing at 1–2° for 1 hr. Increasing amount of precipitation recorded as 1, 2 or 3.

linked galactose residues precipitate the antiserum as readily.

The presence of units containing galactose linked to *N*-acetyl-D-glucosamine in human blood group substances is known from the isolation of O-β-D-galactopyranosyl-(1→4)-*N*-acetyl-D-glucosamine from meconium[10] and more recently from the isolation of (1→3)-, and (1→4)-O-(β-galactopyranosyl)-*N*-acetylglucosamine from *A*-substance of ovarian cyst origin[11]. Cross-reactivity of the blood group substances with antibody to Type XIV pneumococcal polysaccharide could be due to either of these disaccharide units or to some other disaccharide of galactose and *N*-acetylglucosamine which has not yet been identified in the group specific materials. The (1→3) and (1→4) compounds, together with O-β-D-galactopyranosyl-(1→6)-*N*-acetyl-D-glucosamine and a number of other sugars, have therefore been examined for their capacity to inhibit the precipitation of horse Type XIV pneumococcus antibody by preparations of human blood group substances which have been degraded by mild acid or enzyme treatment.

As shown in Table 1, D-galactose and all the methyl glycosides and disaccharides tested which contained D-galactopyranosyl units exhibited some capacity to inhibit precipitation. By far the most effective inhibitor, however, was O-β-D-galactopyranosyl-(1→4)-*N*-acetylglucosamine. The following sugars at a concentration of 1 per cent showed no detectable inhibition in this system : L-fucose, *N*-acetyl-D-glucosamine, α- and β-methyl-*N*-acetyl glucosaminides, *N*-acetyl-D-galactosamine, α-methyl *N*-acetylgalactosaminide, cellobiose and laminaribose. The increased efficiency of O-β-D-galactopyranosyl-(1→4)-*N*-acetyl-D-glucosamine over lactose (O-β-D-galactopyranosyl-(1→4)-glucose) as an inhibitor suggests that, although *N*-acetylglucosamine does not, by itself, prevent precipitation taking place, it plays an important part in the determinant specificity of the Type XIV antibody.

Inhibition reactions with simple substance have been widely used to study the relationship between chemical structure and serological specificity and, in general, the preferential inhibition of a precipitation reaction by a certain substance can be taken as an indication that a similar structure is present in the antigen under investigation[12]. The inference to be drawn from the results presented here, therefore, is that cross-reactivity of the blood group mucopolysaccharides *with Type XIV pneumococcus* antiserum is attributable, at least in part, to the presence in these substances of β-linked 1 : 4 galactopyranosyl-*N*-acetylglucosamine units.

We wish to thank Prof. R. Kuhn for specimens of *(1→3)-* and *(1→6)*-O-β-galactosyl-*N*-acetylglucosamine and Prof. P. Gyorgy for the corresponding O-β-galactosyl-(1→4)-*N*-acetylglucosamine. The investigation was supported by a grant from the Nuffield Trust.

Winifred M. Watkins
W. T. J. Morgan
Lister Institute of Preventive Medicine,
London, S.W.1.
Sept. 26.

[1] Beeson, P. B., and Goebel, W. F., *J. Exp. Med.*, **70**, 239 (1939).
[2] Finland, M., and Curnen, E. C., *Science*, **87**, 417 (1938). Weil, A. J., and Sherman, E., *J. Immunol.*, **36**, 139 (1939).
[3] Kabat, E. A., Bendich, A., Bezer, A. E., and Knaub, V., *J. Exp. Med.*, **87**, 295 (1948).
[4] Morgan, W. T. J., and King, H. K., *Biochem. J.*, **37**, 640 (1943).
[5] Aminoff, D., Morgan, W. T. J., and Watkins, W. M., *Biochem. J.*, **46**, 426 (1950); Annison, E. F., and Morgan, W. T. J., *Biochem. J.*, **52**, 247 (1952). Gibbons, R. A., and Morgan, W. T. J., *Biochem. J.*, **57**, 283 (1954).
[6] Watkins, W. M., *Biochem. J.*, **64**, 21 P (1956).
[7] Kabat, E. A., "Blood Group Substances" (Academic Press, New York, 1956).
[8] Heidelberger, M., Barker, S. A., and Stacey, M., *Science*, **120**, 781 (1954).
[9] Heidelberger, M., *J. Amer. Chem. Soc.*, **77**, 4308 (1955).
[10] Kuhn, R., and Kirschenlohr, W., *Chem. Ber.*, **87**, 560 (1954).
[11] Côté, R., and Morgan, W. T. J., *Nature*, [**178**, 1171 (1956)].
[12] Landsteiner, K., "The Specificity of Serological Reactions" (Harvard Univ. Press, 1947).

## Effect of Butyrate Administration on Blood Glucose in Sheep

The concentration of glucose in the blood of ruminants has been found by earlier workers to change after the administration of butyrate. Blood glucose was depressed in goats after a transient rise[1], raised in adult sheep possibly by a sympatho-adrenal mechanism[2], and elevated in lambs with insulin-induced hypoglycæmia in a way that suggested glycogenesis[3]. Pharmacological reactions and great individual variation between sheep "made any statistical analysis difficult to interpret"[2].

During a study on gluconeogenesis in sheep[4], 500 ml. of a 10 per cent solution of sodium butyrate at *p*H 7·4 was infused during 50 min. into the jugular vein of Merino ewes. The pulse-rate rose to about 150 per min. ; but distress or coma was avoided by the slow infusion. The initial blood glucose was in the normal range, was raised by glucose infusion, or was depressed by a fast of three days. Carotid and jugular blood samples were taken simultaneously before and after infusion and glucose determined[5]. The change in mean blood concentration (arterial plus venous divided by two) was plotted against the initial mean blood concentration (see Fig. 1).

When the blood glucose was initially around the normal average value[6] of 40 mgm./100 ml. it increased during butyrate infusion by 5–50 mgm./100 ml. in all but one case which decreased by 12 mgm./100 ml. When the ewes were fasted for three days, their blood glucose fell to 25–35 mgm./100 ml. and upon butyrate infusion it increased by 50–80 mgm./100 ml. When the blood glucose was high initially, it fell during butyrate infusion. The change in mean

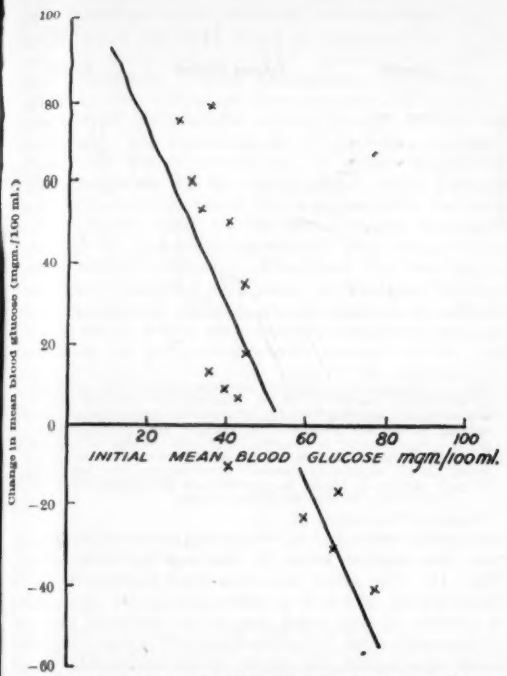



Fig. 1. Change in mean blood glucose in sheep 50 min. after infusion of 10 per cent sodium butyrate

blood glucose correlated with initial mean blood glucose ($r = 0{\cdot}848$) at a highly significant level ($p < 0{\cdot}001$) for fifteen observations.

These results indicate that sheep have a glucostatic mechanism which is facilitated by the administration of butyrate. Apparently gluconeogenesis from butyrate may occur in sheep; the conversion is inhibited by a plethora of glucose and is stimulated by a shortage.

My thanks are offered to Prof. W. V. Macfarlane for advice and encouragement and the Rural Credits Fund of the Commonwealth Bank of Australia for financial assistance.

D. S. Kronfeld
Sir William MacGregor School of Physiology,
University of Queensland,
Brisbane.
Sept. 14.

[1] Schultz, L. H., and Smith, V. R., *J. Dairy Sci.*, **34**, 1191 (1951).
[2] Jarrett, I. G., Potter, B. J., and Filsell, O. H., *Aust. J. Exp. Biol.*, **30**, 197 (1952).
[3] Potter, B. J., *Nature*, **170**, 541 (1952).
[4] Kronfeld, D. S., M.V.Sc. thesis, University of Queensland (1956).
[5] Somogyi, M., *J. Biol. Chem.*, **195**, 19 (1952).
[6] Kronfeld, D. S., *Aust. J. Agric. Res.* (in the press).

## Acquired Resistance to Chloroquine Diphosphate in *P. gallinaceum* in Chicks

Past experiments have shown that acquired resistance in *Plasmodia* to antimalarials can be developed easily and in a short time in certain groups of compounds. *Per contra*, such resistance to some other groups of anti-malarials can be built up either with difficulty or not at all. Proguanil and pyrimethamine belong to the former group, and it is noted that a *Plasmodium* made resistant to one becomes resistant also to the other[1–3].

Quinine, mepacrine, 4-aminoquinolines and 8-aminoquinolines belong to the latter group of compounds to which parasites do not seem to become resistant easily. For example, while Williamson *et al.*[4] failed to demonstrate any such resistance to quinine, Knoppers[5] had ultimately succeeded in developing only a two-fold resistance in *P. gallinaceum*. Again, only a slight degree of resistance could be built up in respect of pamaquine[6,7] and none at all to mepacrine[8,9] or the 4-aminoquinolines[10,11].

The present report records the findings of the development of at least a two-fold resistance to chloroquine diphosphate in *P. gallinaceum* in chicks. Although the exact mechanism of development of such acquired resistance is not fully known, it is noted from previous experience that whenever there had been a failure in the development of such resistance, either the initial dose was high and/or increase in doses was made very rapidly or abruptly. In view of this, during the present investigations, the initial dose administered was fairly low, the dosage schedules were increased cautiously, often the same dose was repeated over and over again, sometimes up to twelve times, during each passage, and lastly the strain was kept continuously exposed to the drug.

The procedure adopted for inoculation, drug administration, etc., was similar to that described earlier by Jaswant Singh, Basu and Ray[12]. Subpassages were carried out on day 4 in respect of every batch after blood smears were taken for parasite count. Along with each experimental group, there was always an untreated group for comparison. The degree of parasitæmia in the experimental group was expressed as a percentage of that observed in the untreated group.

Before commencement of the studies, the minimum effective dose (the lowest dose which would reduce parasitæmia to approximately 25 per cent of the comparison group) of chloroquine diphosphate ('Avloclor', received through the courtesy of Imperial Chemical Industries, Ltd.) was first determined and it was observed to be 0·0615 mgm. per 50 gm. chick (equivalent to 1/26 of the M.E.D. of quinine). For development of acquired resistance, the initial dose selected was 0·05 mgm. per 50 gm., which allowed parasitic development to a reasonable degree (60–70 per cent as compared to the untreated group). The same dose was repeated three times in the succeeding passages before further increase in the schedule to 0·057 mgm. was made. Subsequent schedules were 0·0615, 0·066, 0·08, 0·088, 0·1, 0·114, and 0·123 mgm. per 50 gm. chick. The doses are equivalent to 1/26, 1/24, 1/20, 1/18, 1/16, 1/14 and 1/13 of the M.E.D. of quinine.

After nine months, during which period fifty-seven passages were made, a check test was initiated and repeated several times for confirmation. For this, both the parent strain and the sub-strain were exposed to the same dose of drugs in different batches of chicks. Side by side, untreated batches were kept for comparison. It was observed that under the dosage schedule of 0·0571 mgm., the degree of parasitæmia was somewhat similar (66 and 75 per cent) in respect of the two strains, but in groups treated with 0·0615 (M.E.D.) the parasitic densities were 28·2 and 62·5 per cent in respect of the parent strain and the sub-strain, respectively. In higher dosage schedules like 0·114 and 0·123 (1/14 and 1/13 the M.E.D. of quinine), the parasitic densities in respect of the parent strain

were 0·018 and 0·009 per cent, respectively, against 33·3 and 27 per cent in respect of the sub-strain. In other words, the degree of parasitæmia (27 per cent) in the sub-strain under schedule 0·123 mgm. was about the same (28·2 per cent) as in the case of the parent strain under schedule 0·0615 mgm. At still higher dosage (0·133 mgm.), the infection rate was 6 per cent in respect of the sub-strain.

Therefore, while the M.E.D. for the parent strain was determined to be 0·0615 mgm., that for the sub-strain was 0·123 mgm. Thus the sub-strain could be considered to have developed a two-fold resistance. (Since submission of this communication, the sub-strain has now developed more than three-fold resistance to chloroquine-diphosphate.) Further observations are being continued, and details will be published elsewhere.

A. P. Ray
G. K. Sharma

Malaria Institute of India,
Delhi. Aug. 4.

[1] Jaswant Singh, Ray, A. P., Basu, P. C., and Nair, C. P., *Trans. Roy. Soc. Trop. Med. Hyg.*, **46**, 639 (1952).
[2] Robertson, G. I., Davey, D. G., and Fairley, N. H., *Brit. Med. J.*, ii, 1255 (1952).
[3] Schmidt, L. H., and Genther, C. S., *J. Pharm. Exp. Therap.*, **107**, 61 (1953).
[4] Williamson, J., Bertram, D. S., and Lourie, E. M., *Nature*, **159**, 885 (1947).
[5] Knoppers, A. T., *Nature*, **160**, 606 (1947).
[6] Fulton, J. D., and Yorke, W., *Ann. Trop. Med. Parasit.*, **35**, 233 (1941).
[7] Bishop, A., and Birkett, B., *Parasit.*, **39**, 125 (1948).
[8] Bishop, A., and Birkett, B., *Nature*, **159**, 884 (1947).
[9] Williamson, J., and Lourie, E. M., *Ann. Trop. Med. Parasit.*, **41**, 278 (1947).
[10] Thompson, P. E., *J. Inf. Dis.*, **83**, 250 (1948).
[11] Bishop, A., and McConnachie, E. W., *Parasit.*, **42**, 52 (1952).
[12] Jaswant Singh, Basu, P. C., and Ray, A. P., *Ind. J. Mal.*, **6**, 145 (1952).

## Enhancement of Activity in a Pacinian Corpuscle by Sympathomimetic Agents

It has been shown that the sensory input into the central nervous system can be modulated at the very origin of the nervous message—at the receptor[1]. For example, the response of a cutaneous touch receptor to a constant mechanical stimulus may be increased by excitation of the sympathetic nerve supply to the frog's skin. Only a few sympathetic impulses—in some cases only one—are required to modulate the activity of the receptor. The effect appears to be due to the release of an adrenaline-like substance by sympathetic fibres ending near the tactile receptor[1]. The present communication deals with the facilitatory action of sympathetic amines on an isolated mechano-receptive sense organ.

Pacinian corpuscles of the cat's mesentery were isolated, together with a length of sensory axon. For mechanical stimulation, the deflexions of a piezo-electric crystal produced by square voltage pulses of 0·1 msec. duration were transmitted to the corpuscle by a glass stylus[2]. The deflexions could be varied between 1 and 40$\mu$, their magnitude being a known function of the voltage applied across the crystal. Threshold of the receptor could thus be expressed in terms of the voltage as well as in terms of the displacement of the crystal. The electric activity of the sense organ was led off at its afferent axon while physiological solutions containing test substances could be conveniently applied to the corpuscle. The application of adrenaline or noradrenaline caused a reversible lowering of the corpuscle's threshold for

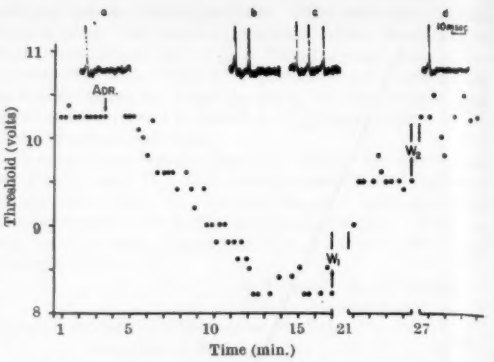



Fig. 1. Changes in excitability and adaptation of the corpuscle by adrenaline. 10 gm. in $10^8$ ml. of adrenaline (*Adr*) are applied at arrow mark, causing lowering of threshold (expressed in volts applied across the piezo-electric crystal) and adaptation-rate (*b*, *c*). Reversibility is obtained after two periods of washing (*W*) with Ringer's solution. *a*, *b*, *c* and *d* are patterns of action potentials in response to threshold stimulation. The beginning of each pattern is placed in approximate accordance with the time along the abscissa

mechanical stimulation, which falls slowly to 90–70 per cent its original value in the course of 2–7 min. (Fig. 1). The effect was observed in 16 out of 19 cases tested and has a latent period of 1½–3 min. A latency of this order was to be expected in view of the very slow diffusion speeds of even relatively small ions across the layers of the corpuscle found by Gray and Sato[3]. Reversibility of the effect was obtained after repeated washing with physiological solution. Pairs or trains of sub-threshold mechanical stimuli which previously failed to excite the corpuscle to firing-level by temporal summation could be shown to add up to threshold during the period of increased excitability produced by the sympathetic agents. In about 20 per cent of the cases tested the addition of adrenaline or noradrenaline caused a reversible lowering of the adaptation-rate. Thus the corpuscle which ordinarily gave only a single impulse in response to a threshold stimulus discharged repetitively after the application of the sympathetic hormones. The appearance of iterated firing of impulses usually ran parallel with the period of highest excitability of the receptor (Fig. 1, *b* and *c*). Care was taken to maintain the stimuli continuously at threshold when the latter was decreasing under the influence of the amines. The repetitive firing appears to indicate, therefore, a genuine change in adaptation of the sense organ.

In a series of experiments a few corpuscles showed 'spontaneous' discharges at a steady rhythm in the absence of external stimulation. The application of adrenaline then caused an increase of 12–25 per cent of the impulse-rate.

Concentrations of 1–10 gm. in $10^6$ ml. of adrenaline or noradrenaline were generally employed for the experiments. But clear effects could already be obtained with doses of 1 gm. in $10^7$ ml.

The mechanism of action of the sympathetic hormones seems to be situated at the impulse generator of the corpuscle. 'Generator potentials' of the corpuscle's nerve ending were recorded with external leads at the emergence of the axon, while propagated action potentials were abolished by procaine[3] or by other blocking procedures. The latter will be described in another publication. The 'generator potentials' showed an increase in peak amplitude,

an increase in rate of rise and, in some cases, a prolongation of its decay time, as a consequence of the addition of adrenaline. As the 'generator potentials' would normally present spontaneous fluctuations in shape in the course of the experiments, statistical analysis of the changes caused by the amines was necessary. The modifications in 'generator potential' mentioned above proved to be highly significant. The possibility of an antagonistic effect between adrenaline and procaine being responsible for these modifications may be discarded, since the same changes in 'generator potential' were found when other entirely different procedures for blocking of the action potential were used. A similarity between the facilitatory effects of adrenaline at diverse structures at which impulses are generated becomes apparent by comparing the increment of the 'end plate potential' of skeletal muscle[4], the alteration in the 'generator potential' of the heart's pacemaker[5,6] and the changes in 'generator potential' of a sensory nerve ending reported here.

This work was aided by a grant from the Rockefeller Foundation.

W. R. Loewenstein
R. Altamirano-Orrego

Instituto de Fisiología,
Universidad de Chile,
Casilla 6524,
Santiago, Chile. Aug. 20.

[1] Loewenstein, W. R., *J. Physiol.*, **132**, 40 (1956).
[2] Gray, J. A. B., and Malcolm, J. L., *Proc. Roy. Soc.*, B, **137**, 96 (1951).
[3] Gray, J. A. B., and Sato, M., *J. Physiol.*, **129**, 594 (1955).
[4] Hutter, O. F., and Loewenstein, W. R., *J. Physiol.*, **130**, 559 (1955).
[5] del Castillo, J., and Katz, B., *Nature*, **175**, 1035 (1955).
[6] Hutter, O. F., and Trautwein, W., *Nature*, **176**, 512 (1955).

## Binding of Histamine in Mammalian Tissues

Much of the histamine in mammalian tissues is contained in tissue mast cells[1]; but it is by no means certain how it is held at high concentration inside these cells. Evidence suggests that the mast cells do not produce the histamine but have a specific faculty of storing this compound. However, storage does not occur until metachromatically staining granules of heparin become visible in the cytoplasm of the cells. Experiments have been carried out, therefore, to study the affinity of histamine and heparin for one another.

When heparin (20 mgm.) and histamine acid phosphate (1 mgm.) are mixed in solution, and alcohol (70 per cent) or acetone is added, the precipitated heparin removes about 70 per cent of the histamine from the solution when the *p*H is around 5. The combination, however, is dependent upon *p*H, since at neutral or alkaline reaction much less histamine is removed by the heparin. Fig. 1 illustrates this point and compares the combination of heparin and histamine base (*B*, *p*H 9) with that of heparin and histamine acid phosphate or dihydrochloride. The precipitated heparin–histamine complex can be washed with alcohol or acetone without loss of histamine, but the complex is easily rendered soluble by water, saline or weak acid. If adenosine triphosphate (1 mgm.) is also present in the solution before precipitation, the uptake of histamine by heparin is increased to more than 90 per cent.

The staining properties (for example, with toluidine blue) and chromatographic behaviour of the complex resemble those of the natural mast cell granules

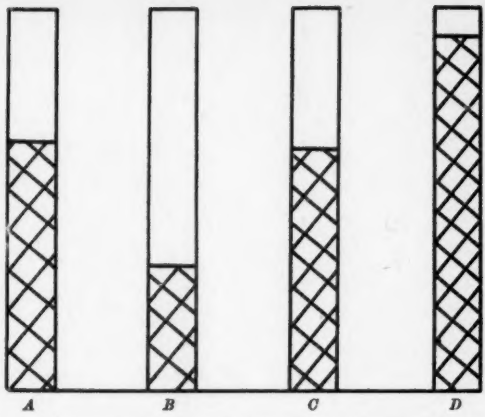



Fig. 1. Diagram to illustrate the distribution of histamine between the supernatant liquid (clear areas) and the precipitate of heparin (shaded areas). *A*, Histamine acid phosphate; *B*, histamine base; *C*, histamine dihydrochloride; *D*, histamine acid phosphate with adenosine triphosphate. All columns represent the means of ten experiments

isolated from mouse connective tissue[2]. Further, the morphological characters of the precipitated complex approximate to those of the living granules.

The formation of the complex is fairly specific for histamine, since adrenaline, noradrenaline and 5-hydroxytryptamine are not removed under similar conditions. Certain basic amino-acids such as arginine, lysine or ornithine combine with heparin when alcohol is added[3]; and it is of interest to find that these amino-acids are bases of sufficient strength to displace histamine from its attachment to the acidic residue of heparin in the tissues by some kind of cation exchange[4].

Thus the base histamine and the acid heparin can form a complex *in vitro*. The proportions of the two substances present in the complex, namely, one part of histamine to twenty parts of heparin, are similar to those found in extracts of tissues which are rich in mast cells[5]. So far it has not been possible to release the histamine from the synthetic histamine heparinate without solution of the heparin.

R. K. Sanyal
G. B. West

Department of Pharmacology,
School of Pharmacy,
Bloomsbury Square,
London, W.C.1.
Sept. 25.

[1] Riley and West, *J. Physiol.*, **120**, 528 (1953).
[2] West, *J. Pharm. Pharmacol.*, **7**, 80 (1955).
[3] Amman and Werle, *Klin. Wschr.*, **34**, 207 (1956).
[4] Eldridge and Paton, *J. Physiol.*, **124**, 27 *P* (1954).
[5] Cass, Riley, West, Head and Stroud, *Nature*, **174**, 318 (1954).

## Enzyme-Substrate Complex Formation : a First Stage in Ribonuclease Activity

The exact intermediate steps in the breakdown caused by ribonuclease enzymic activity awaits clarification in spite of the many methods currently used in the measurement of ribonuclease activity.

The method presented here was found very useful for demonstrating the stepwise ribonuclease enzymic specificity. The technique depends on the fact that basic dyes which normally polymerize in aqueous

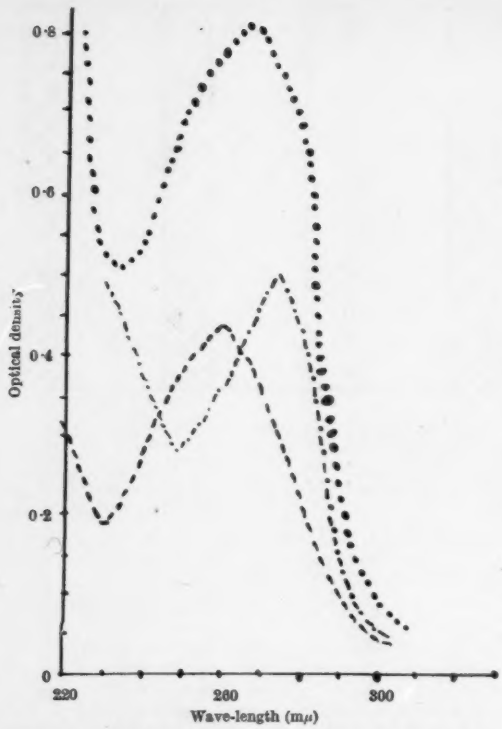



Fig. 1. Absorption curves of the elute: —.—., enzyme (ribonuclease); — — — —, substrate (ribonucleic acid); ....., enzyme-substrate complex (ribonuclease–ribonucleic acid) from the electrogram after ionophoretic separation

solution are depolymerized by nucleic acid, resulting in complex formation. Ionophoretic mobility of the dye–nucleic acid complex resulting is altered as enzymic activity progresses, thus giving a quantitative estimation for the action of ribonuclease on ribonucleic acid.

Using this procedure, an enzyme-substrate complex has been demonstrated using ribonuclease–ribonucleic acid (enzyme-substrate), desoxyribonuclease–desoxyribonucleic acid (enzyme-substrate), desoxyribonuclease–ribonucleic acid (enzyme-competing substrate) and ribonuclease–desoxyribonucleic acid (enzyme-competing substrate).

The materials employed include: (1) yeast ribonucleic acid, prepared and reported by Hakim[1,2]; (2) crystalline ribonuclease (Armour), triply recrystallized by the Kunitz procedure[3]; (3) desoxyribonuclease (Schwartz), recrystallized three times by the Kunitz procedure[4]; (4) sodium desoxyribonucleate, prepared by the method of Kay, Simmons and Dounce[5]; (5) methyl green solution, 0·4 per cent, after exhaustive extraction with chloroform to remove contaminating crystal violet, found by ionophoresis to be present in the commercial sample; (6) methylene blue.

Paper ionophoresis was carried out in type *LKB* 3276 paper ionophoresis equipment, using 40 × 10 mm. Schleicher and Schuell No. 2043 *B* filter paper, and a barbiturate buffer, *p*H 8·5, ionic strength 0·05.

Ribonucleic acid in 15 μl. volumes (1 per cent solution, w/v) was applied about 150 mm. from each end of the ionically equilibrated strips of filter paper, ribonuclease (or desoxyribonuclease) was applied on top of the nucleic acid spot in equal volumes (0·02 per cent solution, w/v). Finally, methyl green (or methylene blue) solution was applied in 5 μml. volumes (0·4 per cent solution, w/v). Four hours after the final application, a potential of 300 volts and 0·5 m.amp. was applied for 24 hr., after which the papers were dried. The location of the dye was noted, marked with a pencil, and the papers were stained with bromphenol blue to locate the position of the proteins. Experiments were run in triplicate on three parallel strips of filter paper. After ionophoresis and drying of the three ionograms, one strip was stained with bromphenol blue. In all cases, the enzyme-substrate complex was located at the line of application, while the different enzymes showed their own characteristic ionophoretic mobilities. Elution was accomplished in phosphate buffer *p*H 5·64, ionic strength 0·05, and activities of the eluates determined. Ribonuclease activity was measured by following the optical density of methylene blue (0·20 mgm./ml.) and ribonucleic acid (5 mgm./ml.), at 5500 A., as a function of time, following the addition of the eluate[6]. Desoxyribonuclease activity was measured by the Kunitz method[4].

Figs. 1 and 2 show the ultra-violet spectrophotometric spectra of the eluted enzyme (ribonuclease, or desoxyribonuclease), enzyme-substrate complex (ribo-

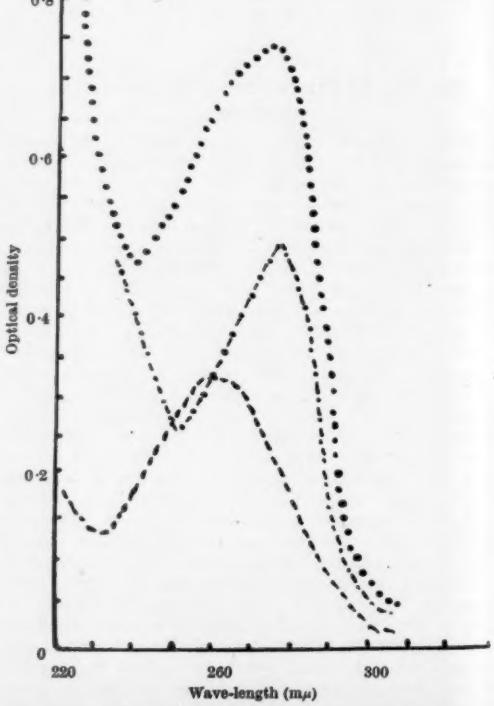



Fig. 2. Absorption curves of the elute: —.—., enzyme (desoxyribonuclease); — — — —, substrate (desoxyribonucleic acid); ....., enzyme-competitive substrate (desoxyribonuclease–ribonucleic acid) from the electrogram after ionophoretic separation

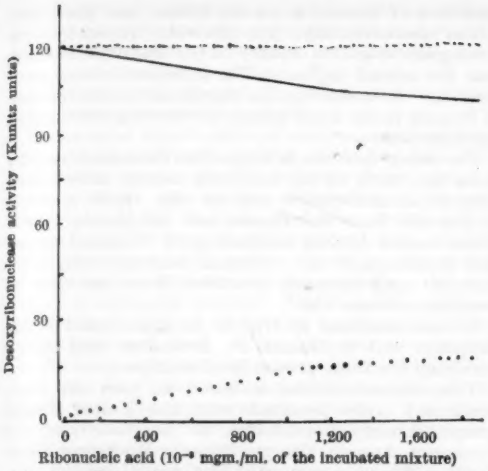



Fig. 3. Desoxyribonuclease inhibition by ribonucleic acid: —.—., enzyme (desoxyribonuclease) added; ———, enzyme (desoxyribonuclease) found; ....., per cent inhibition

nuclease–ribonucleic acid, or desoxyribonuclease-desoxyribonucleic acid), enzyme-competitive substrate (desoxyribonuclease–ribonucleic acid), and substrate (ribonucleic, or desoxyribonucleic acid).

Figs. 3 and 4 show the results of experiments on paper ionophoresis, where fixed amounts of ribonuclease were incubated with increasing amounts of desoxyribonucleic acid on ionically equilibrated filter paper at room temperature. Ribonuclease activity then was titrated against yeast ribonucleic acid. In all cases the enzymic activity was found in the mobile fraction and not in the enzyme-competitive substrate complex, which remained at the point of application after ionophoresis. Similarly, fixed amounts of desoxyribonuclease were incubated with increasing amounts of ribonucleic acid and desoxyribonuclease activity was titrated against desoxyribonucleic acid (Fig. 3).

The competitive action between desoxyribonucleic acid and ribonucleic acid for ribonuclease has been demonstrated. The competition is due to the formation of complexes composed of the enzyme with either of the two acids.

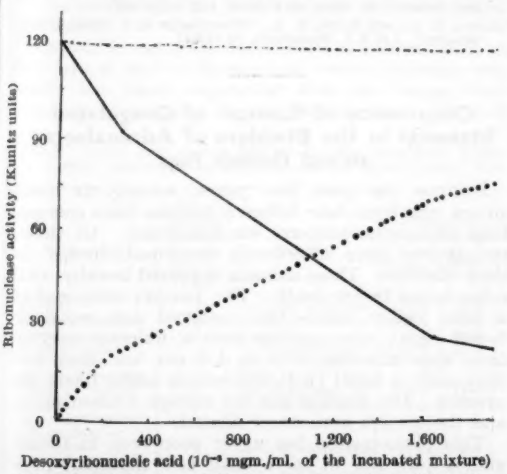



Fig. 4. Ribonuclease inhibition by desoxyribonucleic acid: —.—., enzyme (ribonuclease) added; ———, enzyme (ribonuclease) found; ....., per cent inhibition

This work was started during a visit to the Department of Experimental Pathology and Cancer Research, Leeds. The work was repeated and similar results were obtained in the Department of Medical Research, National Children's Cardiac Hospital, Miami, Florida.

ANWAR A. HAKIM
National Children's Cardiac Hospital,
Miami, Florida.
Sept. 17.

[1] Hakim, A. A., 3ème Congrès International de Biochimie, Bruxelles, 1–6 Aout, 1955, Sect. 8, 70.
[2] Hakim, A. A., *Enzymologia* (in the press).
[3] Kunitz, M., *J. Gen. Physiol.*, **24**, 15 (1940).
[4] Kunitz, M., *J. Gen. Physiol.*, **33**, 363 (1950).
[5] Kay, E. R. M., Simmons, N. S., and Dounce, D. L., *J. Amer. Chem. Soc.*, **74**, 1724 (1952).
[6] Shugar, D., *Bull. Acad. Polon. Sci.*, **1**, 39 (1953).

## Distribution in the Soft Tissue of the Rat of Radioactive Fluoride administered as Sodium Fluoride

BECAUSE the analysis of soft tissue for fluoride is difficult, little has been published on the distribution of fluoride in tissues other than bone, dentine and enamel. Data of this nature are of interest in view of the widespread use of fluorides in drinking water as a caries-preventive measure. Such data also may be useful in assessing the fluoride exposures of livestock pastured near certain industrial plants.

Preliminary experiments in which rats were given radiofluorine, reported here, afford additional insight into a number of aspects of fluoride metabolism. Radioactive fluoride was prepared by proton bombardment, in the small cyclotron of the University of Rochester Physics Department, of frozen samples of water enriched in oxygen-18. Following a 4–6 hr. bombardment, the ice now containing radioactive fluoride was melted, transferred to a 5-ml. volumetric flask containing aqueous sodium fluoride, and the solution brought to volume with distilled water; the final fluoride concentration was 1 p.p.m. Three different solutions were prepared; a different solution was used in each of the three distribution experiments (Table 1). Since samples from three different bombardments were employed, the data have been adjusted to the same activity, namely, 1,416, 200 counts per minute per microgram of fluoride, to facilitate comparison. The decay curve was determined for each sample. The half-life closely approximated 115 min.; in no instance was contaminant radioactivity detected.

At various intervals after administering the radioactive fluoride, the rats were killed by ether anæsthesia. The organs were removed in their entirety, with considerable care taken to minimize contamination by extraneous blood. The tissues were weighed, placed in beakers containing 20 per cent sodium hydroxide and digested on a hot plate as rapidly as possible. The digests were transferred to suitable volumetric flasks, diluted to volume, and 1-ml. aliquots counted by a surface-counting technique.

The experimental design was as follows.

*Rat I:* Four ml. of sodium fluoride solution containing 1 p.p.m. fluoride were administered by

Table 1. Distribution of Fluoride in the Rat following Administration of 1 p.p.m. Fluorine as Sodium Fluoride in Water

| Animal No. | I | | II | | III | |
|---|---|---|---|---|---|---|
| Route of administration | per os | | intravenous | | intravenous | |
| Dose | 4 μgm. fluorine | | 1 μgm. fluorine | | 1 μgm. fluorine | |
| Time to sacrifice | 30 min. | | 10 min. | | 90 min. | |
| Body-weight | 170 gm. | | 147 gm. | | 171 gm. | |
| Tissue | % dose/ organ | % dose/ gm. | % dose-organ | % dose/ gm. | % dose/ organ | % dose/ gm. |
| Brain | 0·04 | 0·03 | 0·06 | 0·05 | 0·04 | 0·03 |
| Parotid glands | 0·07 | 0·21 | 0·04 | 0·16 | 0·03 | 0·14 |
| Submaxillary and sublingual glands | 0·06 | 0·15 | 0·24 | 0·64 | 0·03 | 0·06 |
| Thyroid | 0·01 | 1·17 | 0·009 | 2·17 | 0·02 | 0·09 |
| Heart | 0·08 | 0·13 | 0·18 | 0·37 | 0·03 | 0·03 |
| Lungs | 0·14 | 0·18 | 0·43 | 0·48 | 0·12 | 0·07 |
| Stomach | 41·30 | 9·16 | 0·53 | 0·27 | 0·09 | 0·02 |
| Small intestine | 14·95 | 1·61 | 2·54 | 0·28 | 1·09 | 0·16 |
| Large intestine | 0·49 | 0·08 | 0·71 | 0·02 | 0·41 | 0·06 |
| Liver | 1·84 | 0·19 | 4·69 | 0·67 | 0·67 | 0·06 |
| Spleen | 0·24 | 0·14 | 0·38 | 0·48 | 0·14 | 0·10 |
| Kidneys | 0·70 | 0·45 | 3·03 | 2·29 | 2·41 | 1·20 |
| Adrenals | 0·01 | 0·23 | 0·03 | 0·69 | 0·01 | 0·14 |
| Uterus | 0·09 | 0·22 | 0·05 | 0·15 | 0·02 | 0·07 |
| Muscle | 0·07 | 0·16 | 0·06 | 0·25 | 0·02 | 0·04 |
| Bone | — | — | 0·53 | 1·26 | 0·37 | 1·92 |
| Carcass | 11·27 | 0·09 | 37·60 | 0·32 | 20·81 | 0·16 |
| Blood | — | 0·93 | — | 2·98 | — | 0·11 |
| Urine | — | — | — | — | — | 15·38/ ml. |
| Total | 71·4 | | 51·1 | | 26·9 | |

stomach tube to an adult, female, albino rat; the animal was killed after 30 min. This procedure should give preliminary data on the soft-tissue distribution of fluoride as normally consumed per os.

*Rat II:* One ml. of the fluoride solution was injected into the femoral vein of an adult, female, albino rat; the animal was killed after 10 min.

*Rat III:* One ml. was given intravenously to an adult, female, albino rat which was killed 90 min. afterwards.

Results are given in Table 1. In the time available, total digestion of the carcass and skeleton was not accomplished; this accounts in great part for the low total recoveries obtained. The best recovery was obtained following oral administration; in this experiment more than half the administered dose was found in the stomach and small intestine, both easily digested organs. However, the relative distribution of fluoride can be compared in a number of the soft tissues.

The thyroid, kidneys, and adrenal glands contain the highest concentrations of fluoride following oral administration or 10 min. after intravenous administration. 90 min. after receiving fluoride by vein the kidneys and adrenals still contain the highest concentrations with somewhat less fluoride in the thyroid gland. By this time the parotid glands and spleen show increased fluoride concentration. The uptake of fluoride by the thyroid is in agreement with earlier work from this laboratory in which tissues were analysed chemically[1], but differs from the data of Wallace-Durbin, who found no accumulation of fluorine-18 by the rat thyroid[2]. The increased concentration in the parotid glands after 90 min. is in agreement with the results of Wallace-Durbin[2], Wills[3], and Volker, Sognnaes and Bibby[4], and is consistent with the view that these glands are sites of excretion of fluoride. The principal route of excretion of fluoride is via the kidney into the urine. Given intravenously, the fluoride concentrations were greatest in this organ; in the oral experiment it was the second highest. The intestinal secretion of fluoride[1,5] is revealed by the significant concentrations of fluoride in the small intestine following intravenous administration.

The sharp decrease in tissue fluoride concentrations from the tenth to the ninetieth minute after intravenous administration reflects the rapid removal of fluoride from the tissues and circulating blood. These results confirm the findings of Wallace-Durbin[2] and Parkinson *et al.*[5]. Normal human adults have excreted approximately one-third of an oral dose of fluoride in about 3 hr.[6].

We are indebted to Drs. J. A. Bruner and D. A. Bromley, and to Messrs. M. Awshalom and R. A. Campbell for these proton bombardments.

This communication is based in part on work performed under contract with the United States Atomic Energy Commission at the University of Rochester Atomic Energy Project, Rochester, New York, and in part supported by Grant *G*-3696(c) from the National Institutes of Health, to Eastman Dental Dispensary.

John W. Hein

Colgate-Palmolive Co.,
105 Hudson St.,
Jersey City, N.J.

John F. Bonner

Division of Biology and Medicine,
U.S. Atomic Energy Commission,
Washington 25, D.C.

Finn Brudevold

Eastman Dental Dispensary,
Rochester, New York.

Frank A. Smith
Harold C. Hodge

School of Medicine and Dentistry,
University of Rochester. Sept. 24.

[1] Smith, F. A., Gardner, D. E., and Hodge, H. C., *A.M.A. Arch. Indust. Health*, **11**, 2 (1955).
[2] Wallace-Durbin, P., *J. Dent. Res.*, **33**, 789 (1954).
[3] Wills, J. H., *J. Dent. Res.*, **19**, 585 (1940).
[4] Volker, J. F., Sognnaes, R. F., and Bibby, B. G., *Amer. J. Physiol.*, **132**, 707 (1941).
[5] Parkinson, jun., J. D., Whitney, I. B., Monroe, R. A., Latz, W. E., and Comar, C. L., *Amer. J. Physiol.*, **182**, 383 (1955).
[6] Hodge, H. C., and Smith, F. A., "Fluoridation as a Public Health Measure". A.A.A.S. Monograph, 94 (1954).

## Occurrence of 'Lumps' of Coagulated Material in the Bladders of Adrenalectomized Guinea Pigs

During the past five years, seventy-six male guinea pigs from four different colonies have successfully undergone bilateral adrenalectomy. Of these, twenty-two have afterwards developed 'lumps' in their bladders. These animals appeared healthy until a few hours before death. The 'lumps', composed of a firm yellow cheese-like material and weighing 9–800 mgm., were circular with a diameter varying from approximately 0·25 to 1·0 cm. and they had frequently a small projection which might block the urethra. The bladder did not always contain urine, and the ureters were never dilated.

This phenomenon has never been seen in female guinea pigs nor in more than two thousand male guinea pigs killed or dying from other causes. It has only been observed in male animals which have

been completely adrenalectomized for periods of four days to one year and either maintained on cortisone or deoxycorticosterone acetate or untreated apart from glucose–saline to drink. The lumps did not develop until both adrenal glands had been removed. There was no seasonal incidence.

Histological examination of sections (stained with hæmatoxylin and eosin) of the kidneys of four such animals was carried out. The kidneys of one appeared to be normal; but in the other three there was hyperæmia of the medulla, and also of the cortex in one animal. Two animals showed some cloudy swelling of the tubules, and in one there were zones of polymorph infiltration in the medulla. All the glomeruli appeared normal. The ureters, bladder and seminal vesicles were also sectioned, but no abnormality was seen. Urine samples were tested for albumen with salicylsulphonic acid. A positive result was sometimes obtained with urine from both normal and adrenalectomized animals; but there was no evidence of increased albuminuria or polyuria in adrenalectomized guinea pigs.

It seemed most probable that the coagulated secretion of seminal vesicles was the main constituent of the 'lumps'. Smears made of seminal vesicle secretion and those taken from the 'lumps' had a similar microscopic appearance and showed varying-sized rosettes of amorphous material. The similarity was even more striking when the smears were made from secretion which was first coagulated by immersing the whole vesicle in hot water. No spermatozoa have ever been seen in smears from either the secretions or the 'lumps'.

In the guinea pig, a greater amount of fluid is contributed to the semen by the seminal vesicles than by the rest of the accessory glands together[1]. Mann[1] has shown that the seminal vesicle secretion contains appreciable amounts of citric acid of the order of 200 mgm./100 ml.

In the present study, citric acid was determined by the method of McArdle[2] in the seminal vesicle secretion and in 24-hr. samples of urine collected from normal and adrenalectomized animals with and without 'lumps', in the 'lumps' themselves and in the urine recovered from the bladders of adrenalectomized animals at autopsy.

The results of citric acid analyses are summarized in Table 1.

As can be seen, the concentration of citric acid in the 'lumps' and in the seminal vesicle secretion was nearly the same, suggesting that the lumps were made up of coagulated vesicular secretion. It is of interest that the citric acid content of 24-hr. urine samples was higher in cortisone-treated or untreated adrenalectomized guinea pigs than in normal unoperated animals. The urine in the bladder of one adrenalectomized guinea pig not included in the series of figures given contained 737 mgm. citric acid/100 ml. urine. The urine was cloudy while in the bladder, and as soon as it was aspirated into the glass syringe it formed a solid mass.

Table 1. Citric Acid in the Seminal Vesicle Secretion, Urine and 'Lumps' removed from the Bladders of Male Guinea Pigs

| Guinea pig | No. of animals used in the determinations | Material | Citric acid (± standard error) (mgm./100 ml.) |
|---|---|---|---|
| Normal | 4 | Vesicular secretion | 174·0 ± 29·4 |
| Adrenalectomized | 12 | Vesicular secretion | 195·5 ± 16·3 |
| Adrenalectomized | 8 | 'Lumps' | 192·0 ± 34·8 |
| Adrenalectomized, with 'lumps' | 7 | Urine in the bladder at autopsy | 66·8 ± 10·5 |
| Adrenalectomized, without 'lumps' | 4 | Urine in the bladder at autopsy | 94·1 ± 33·0 |
| Normal | 5 | 24-hr. urine sample | 5·3 ± 0·6 |
| Adrenalectomized, maintained on cortisone | 4 | 24-hr. urine sample | 28·8 ± 9·3 |
| Adrenalectomized, no treatment for 6–24 days | 9 | 24-hr. urine sample | 41·5 ± 14·5 |

The actual cause of death was not evident. It seems unlikely that renal failure was the cause, since the onset of the terminal condition was very rapid; albuminuria was not gross, anuria did not develop, and the bladder was not always obstructed or distended.

It is well known that in some species, notably rodents, semen coagulates after ejaculation; in the guinea pig, coagulation normally occurs after mating so that a vaginal plug is formed. The tentative suggestion is made that in the adrenalectomized guinea pig, whether treated or untreated, the normal process of ejaculation and coagulation is disturbed and that coagulation takes place in the bladder; the 'lump' thus formed can no longer be ejaculated.

We are grateful to Dr. T. Mann for helpful discussion. The cortisone used in the maintenance of the adrenalectomized animals was a gift from the Medical Research Council.

Barbara E. Clayton
Joyce E. Hammant
Joyce B. Hawkins

Department of Chemical Pathology,
St. Thomas's Hospital Medical School,
London, S.E.1.
Sept. 26.

[1] Mann, T., "The Biochemistry of Semen", 20 (Methuen and Co., Ltd., London, 1954).
[2] McArdle, B., *Biochem. J.*, **60**, 647 (1955).

## Communal Oviposition in *Simulium damnosum* Theobald (Diptera, Simuliidae)

*Simulium damnosum* is the main vector of human onchocerciasis over a large part of tropical Africa. Although a considerable amount of work has been done on the habits of this insect—as summarized by Freeman and de Meillon[1]—there are many points in its biology which are still obscure, one of the most important of these being the normal method and site of oviposition. The only published description of the egg-laying habits of this species is that of Wanson and Henrard[2], who recorded thirty-five egg batches on specially attractive breeding sites mainly in the form of floating and vertical artificial frameworks of *Pennisetum* stems. Eighteen of these batches were deposited on the floating stems, thirteen on the vertical stems and four on artificial accumulations of stones. Ovipositing females did not penetrate the water but were observed to lay their eggs at or just above water-level; the egg batches consisted of 200–250 eggs. There is no record of the time of day on which oviposition was observed.

Since these observations were made, very little additional information on *Simulium damnosum* has appeared; but several illuminating observations have been made on species of *Simulium* in other countries which reveal a wide range of ovipositing behaviour both with regard to method and time. For example,

Dalmat's observations on the blackflies of Guatemala[3], particularly those incriminated as vectors of onchocerciasis, showed that *S. ochraceum* oviposits by hovering above the less-turbulent parts of the stream and dropping relatively few eggs in any one place on the floating emergent vegetation. In the case of *S. metallicum* two methods of oviposition were observed; in a rapid current the female approaches the appropriate leaf at the surface of the water and deposits an egg without apparently landing. It then hovers above the leaf and returns to the same spot to deposit the second egg. In slow-moving streams the fly will actually land on the leaf, and several females —up to thirty—have been seen ovipositing on a single leaf. *S. callidum* was seen to oviposit only on sharply inclined surfaces of rock where the current was not very strong. The female hovers and then lands only long enough to deposit one egg, flying away to repeat the performance on another suitable surface. The time of oviposition of these three species was observed to be mainly between noon and 2 p.m. for *S. ochraceum*; between 5 and 6 p.m. (or occasionally as early as 3 p.m.) with *S. metallicum* and usually between 3.30 and 5.30 p.m. in *S. callidum*.

A further variation in ovipositing behaviour is shown by some North American species. *Simulium venustum*, for example, exhibits communal oviposition[4] while with *S. arcticum* it is considered that oviposition generally takes place on the surface of the river water, eggs being laid singly and sinking to the bottom[5].

In view of the wide potential range of behaviour likely to be encountered and of the paucity of observations on such an important species as *S. damnosum*, it was felt that a strenuous effort should be made to investigate this aspect of behaviour. The Liberian Institute provided unusual opportunities for this kind of work, as breeding of *S. damnosum* was found to occur regularly in parts of a comparatively small stream only 12 miles from the Institute. Repeated observations over several months, however, failed to reveal any sign of ovipositing females or of egg batches, even during periods of dense breeding. Finally, in March of this year *Simulium* eggs were found on several broad leaves of bushes dipping into the stream, bushes which had recently been cut down along the stream edge. The eggs were laid in large irregular masses, sometimes distinct, sometimes contiguous. As the eggs were piled in several layers it was difficult to assess their density or number; but a rough estimate showed that two to three thousand eggs per square centimetre was not unusual. On one particular leaf with a continuous egg mass about 30 sq. cm. it was estimated that there must have been at least 50,000 eggs. Provided the leaf surface was kept moist with spray it was found that the egg masses would extend two or three inches above the actual water surface. As larvæ hatching from these eggs could not be kept alive longer than a few days it was not possible to attribute them definitely to *S. damnosum*, as other species, particularly *S. cervicornutum* and *S. unicornutum*, were also present in this stream and on the trailing leaves.

In the following weeks many similar sites were examined, and further batches of eggs were seen twice on trailing leaves and twice on rattan strands dipping into the water. On the assumption that these egg masses were very likely those of *S. damnosum* it was already fairly clearly indicated that such masses could only have been produced by a large number of females, very likely ovipositing at one time. As observations carried out throughout the greater part of the day had failed to reveal any sign of ovipositing females, it also seemed increasingly likely that egg-laying would be restricted to the late afternoon or evening. The opportunity for confirming this point had to await a suitable combination of circumstances, the right time and the right place.

In the month of August, during a period of dense breeding of *S. damnosum*, one particular series of artificial sites in the form of leafy twigs dipping into the stream proved to be an unusually attractive ovipositing site in that fresh batches of eggs were recorded, not spasmodically but on several consecutive days. A careful watch was therefore kept on this spot during the hour before dusk. No fly activity was evident until dusk, when at about 1850 G.M.T. (sunset 1852 G.M.T.) a dense swarm of black flies was seen just above the surface of the water at the point where the tips of the leaves dipped into the stream. The swarm quickly settled on the trailing leaves and mass oviposition started immediately. On one leaf the swarm of flies, now obviously *S. damnosum*, settled at the tip trailing downstream and moved steadily from apex to base. As the mass of flies moved from the narrow tip to the broader part of the leaf they formed a solid line extending from one side to the other. As the line advanced steadily towards the base of the leaf the surface of the leaf behind them was left covered with a carpet of glistening white eggs (which turned brown during the course of the following few hours). As the flies moved upwards the entire leaf surface was covered with the white egg mass. Similar activity was also taking place on the two or three adjacent leaves of this twig, but not on any of the other eight similar twigs trailing in the stream at this point. By the time maximum ovipositing activity had been reached the waning light was making visibility difficult, and it is doubtful if the ovipositing swarm would ever have been spotted if attention had not been concentrated on this one suspected site.

When the peak of activity was already past, specimen tubes slipped quickly over two of the leaf tips secured 48 and 50 *damnosum* females respectively. As many flies escaped and as many others had already left the leaf it is fairly certain that two or three hundred females must have taken part in the pre-oviposition swarm and in the communal ovipositing itself. As a single female may lay several hundred eggs (200–250 according to Wanson and Henrard[2], or even up to 500[6]) it is now possible to understand how the previous estimate of anything up to 50,000 eggs on one leaf is not unreasonable.

This communal oviposition of *S. damnosum* appears to resemble in many respects that described for *S. venustum* (Hocking and Pickering, *loc. cit.*), in which the authors say that "egg-laying females were so numerous that they were lined up closely side by side while others crawled over them seeking a place". As far as *S. damnosum* itself is concerned this communal oviposition is evidently the regular method of ovipositing on this type of site, a leaf or branch trailing in the stream. On the other occasions when eggs have been found on such sites, whether natural or artificial, they have been in the form of large masses, undoubtedly the product of many females; and in all those cases the appearance and dimensions of the eggs agreed with those of eggs actually laid by observed *S. damnosum* females. The dimensions of the *damnosum* eggs—as judged by a random sample of 20—were as follows:

| | Length | Greatest breadth |
|---|---|---|
| Range | 203–245 microns | 126–140 microns |
| Mean | 222$\mu$ | 134$\mu$ |

The observations of Dalmat quoted above to the effect that one species of *Simulium* may vary its ovipositing habits according to site and conditions, combined with the rather different behaviour of *damnosum* originally recorded by Wanson and Henrard[2], make it inadvisable to conclude that this communal ovipositing of *S. damnosum* is an unvarying feature of the species. As such ideal sites in the form of leafy twigs trailing in the turbulent part of the stream are rather unusual, other sites must be used as well in order to account for the almost continuous production of *S. damnosum* larvæ in this stream over long periods. Further observations are being made to investigate this point.

R. C. Muirhead-Thomson

The Liberian Institute of the American Foundation for Tropical Medicine,
Harbel, Liberia,
West Africa.
Sept. 17.

[1] Freeman, P., and de Meillon, B., "Simuliidae of the Ethiopian Region", 224 (British Museum (Natural History), 1953).
[2] Wanson, M., and Henrard, C., *Rec. Trav. Sci. Med. Congo Belge*, **4**, 113 (1945).
[3] Dalmat, H. J., *Smithson. Misc. Coll.*, **125**, No. 1 (1955).
[4] Hocking, B., and Pickering, L. R., *Canad. J. Zool.*, **32**, 99 (1954).
[5] Fredeen, F. J. H., Rempel, J. G., and Arnason, A. P., *Canad. Entom.*, **83**, 3, 373 (1951).
[6] Lewis, D. J., *Bull. Ent. Res.*, **43**, 597 (1953).

## Effect of Changes in Humidity on the Toxicity and Distribution of Insecticides sorbed by some Dried Soils

Recently it has been noticed during field trials in mosquito control that there is an apparent correlation between relative humidity and the insecticidal effectiveness of deposits in houses made of mud walls and thatched roofs. Bordas and Navarro[1] in Mexico found a steady increase in toxicity of dieldrin deposits as the relative humidity increased throughout the season. Burnett[2] in Taveta, Kenya, found that seasonal variations in rainfall, presumably accompanied by variations in humidity, were associated with corresponding changes in the mortalities of mosquitoes exposed to dieldrin deposits.

Relative humidity could presumably exert its influence either upon the insect itself after the insecticide has been picked up or it could modify the availability of the insecticide in the deposit, and these two aspects have now been examined in laboratory experiments.

We have not been able to find any effect of changes in relative humidity upon the kills of mosquitoes which were kept at humidities ranging from 20 to 95 per cent after topical application of DDT, gamma-BHC, dieldrin or 'Diazinon', or after exposure to deposits of wettable powders of DDT, gamma-BHC or dieldrin. Therefore it seems most likely that any influence of relative humidity is upon the availability of the insecticide to the insect.

It has been shown previously[3,4] that the air-dried soils which are frequently used for house construction in the tropics can rapidly adsorb insecticides applied as surface deposits of wettable powders. This process results in a marked decrease in contact action of DDT and dieldrin because there are no longer any particles of insecticide lying on the surface of the house walls. We noticed in this work[3] that relative humidity had an influence upon the rates at which DDT and gamma-BHC thus disappeared; increasing the humidity reduced the rate of loss. It is therefore possible that the behaviour of deposits observed in field trials could be due to variations in the availability of insecticides on and in mud walls and this has been more fully investigated.

Table 1. The Effect of Changes in Relative Humidity upon the Toxicity of Dieldrin-treated Mud Blocks to *Aedes aegypti* Females

| Relative humidity conditions | Percentage kill 24 hr. after exposure of ... min. | | | |
|---|---|---|---|---|
| | 4 | 8 | 16 | 32 |
| 90 per cent for 24 hr. | 55 | 100 | 100 | |
| 40 per cent for 24 hr. | | 0 | 30 | 68 |
| 90 per cent blocks transferred to 40 per cent for 24 hr. | | 0 | 5 | 48 |
| 40 per cent blocks transferred to 90 per cent for 24 hr. | 38 | 65 | 100 | |

It was confirmed that deposits of DDT, gamma-BHC and dieldrin on blocks of Uganda soil are sorbed at rates which decrease as the humidity increases. This was also observed on nine other soils of varying composition and origin. However, dieldrin, which was the insecticide of major interest with field experiments, even at a dosage of 100 mgm. per sq. ft. and at 90 per cent relative humidity, still disappeared from the surface of Uganda mud blocks in about five days, and so for interpretation of the field results it is of more importance to know what happens after sorption is completed. Table 1 shows the results of biological tests with mud blocks sprayed twenty-one days previously with a suspension of dieldrin crystals in the size range 0–10 microns at a dosage of 100 mgm. per sq. ft. and kept for 24 hr. at two different humidities before the exposure of mosquitoes. The positions of the blocks were reversed for a further 24 hr. and re-tested.

It can be seen that the insecticidal activity increases with humidity from 40 to 90 per cent and this difference in activity is almost completely reversible in 24 hr. Similar results were obtained for contact action of DDT and both contact and fumigant action of gamma-BHC. The kills therefore follow closely any changes in humidity and the biological effectiveness of the treated blocks can be rapidly raised or lowered. Because of this close correspondence it seemed unlikely that there could be any marked changes in distribution of insecticide as postulated by Bordas and Navarro[1], who suggested that the insecticide migrated back to the surface under conditions of high humidity. This was borne out by chemical determination of the distributions of the insecticides in the blocks kept at different humidities. These showed that the rate of diffusion of the insecticides into the blocks after sorption was complete actually increased with humidity and this naturally resulted in a decreased concentration of insecticide near the surface of the blocks on which the insects rested. Table 2 gives some results obtained with dieldrin-treated blocks kept at different humidities after spraying.

In the field, therefore, long periods of high humidity would be expected to give a progressive decrease in the concentration of insecticides near the surface of the walls whereas lower humidities would tend to keep the concentration static. At any given time and

Table 2. Average Percentage Recoveries of Dieldrin from Successive Layers of Uganda Mud Blocks

| Relative humidity (per cent) | Layer No. | Weight of layer (gm.) | Time after spraying | | |
|---|---|---|---|---|---|
| | | | 1 hr. | 4 days | 13 days |
| 10 | 1 | 0·25 | 92 | 69 | 52 |
| | 2 | 4·0 | 8 | 31 | 48 |
| | 3 | 4·0 | 0 | 0 | 0 |
| | 4 | 4·0 | — | — | 0 |
| | 5 | 4·0 | — | — | 0 |
| 50 | 1 | 0·25 | 92 | 17 | 10 |
| | 2 | 4·0 | 8 | 79 | 67 |
| | 3 | 4·0 | 0 | 4 | 20 |
| | 4 | 4·0 | — | 0 | 3 |
| | 5 | 4·0 | — | — | 0 |
| 90 | 1 | 0·25 | 92 | 16 | 6 |
| | 2 | 4·0 | 8 | 37 | 23 |
| | 3 | 4·0 | 0 | 27 | 20 |
| | 4 | 4·0 | — | 20 | 15 |
| | 5 | 4·0 | — | — | 12 |
| | 6 | 4·0 | — | — | 10 |
| | 7 | 8·0 | — | — | 14 |

concentration, however, an increase in humidity would give higher kills, and a decrease lower kills. The enhanced kill at high humidities can more than compensate for decreases in concentration so that kills would remain high even during extended periods of high humidity.

We explain these results on the basis of competition between the water and the insecticides. Water appears to be adsorbed preferentially to the insecticide and the increased amounts which are present in soils at high humidities have two effects. The initial disappearance of the insecticide from solid particles lying on the surface is retarded because water molecules already occupy a large proportion of the 'active' surface of the soil and cannot be displaced. Once the insecticide is adsorbed, however, the same preferential adsorption of water results in an increased mobility of the insecticide molecules and therefore an enhanced rate of diffusion farther into the soil or, alternatively, an enhanced rate of diffusion on to and into an insect resting on the soil.

The laboratory findings therefore provide an explanation for the results obtained in the field by Burnett and by Bordas and Navarro where mosquitoes enter huts and can be killed by contact or fumigant action on treated walls.

F. Barlow
A. B. Hadaway

Colonial Insecticides Research,
Porton.
Sept. 17.

[1] Bordas, E., and Navarro, L., WHO (Malaria), 125 (Geneva, 1955).
[2] Burnett, G., *Nature*, **177**, 663 (1956).
[3] Hadaway, A. B., and Barlow, F., *Bull. Ent. Res.*, **43**, 281 (1952)
[4] Barlow, F., and Hadaway, A. B., *Bull. Ent. Res.*, **46**, 547 (1955).

## Reactions to Shading in the Sea Urchin, *Psammechinus miliaris* (Gmelin)

In this urchin, podia withdraw in response to sudden shading. When the aboral hemisphere was subjected to an illumination of 250 metre-candles from a tungsten filament lamp, according to the individual, a 3–20 per cent decrease in intensity proved a minimal stimulus. Most of the podia responded simultaneously when the light was relatively bright; but when dim, or when the shadow was faint, many fewer responded and then at different times.

By using calibrated neutral filters it was found that the interval between instantaneous shading and the appearance of a clearly visible response varied inversely with the intensity of illumination and the degree of intensity change.

In successive experiments with an illumination of more than 100 metre-candles, in response to a 20 per cent decrease, this interval was approximately constant for each individual, but at 5–20 metre-candles it varied considerably. Despite such variations, there was sometimes an indication of adjustment, in that this period decreased in successive experiments under the same conditions.

Urchins must be exposed to light for a certain length of time before they react to shading, the duration varying inversely with the light intensity. Different individuals required 0·5–2·0 min. at 60 metre-candles, and 3–22 min. at 6 metre-candles. The response thus depends, in part at least, on photochemical reactions.

The relative effectiveness of exposure to light in regions of the spectrum between 400 and 560 mμ and between 620 and 700 mμ was determined by means of four coloured filters with known transmission, and a light source of known colour temperature. For this response, using the relative amount of light energy transmitted by the filters as a basis for comparison, the animal appeared most sensitive between 440 and 560 mμ.

The work was done at the Plymouth Laboratory of the Marine Biological Association, and a full account will be published later.

N. Millott
M. Yoshida

Department of Zoology,
Bedford College
(University of London),
Regent's Park,
London, N.W.1.
Sept. 27.

## Plastochron Determination in *Ranunculus* using Carbon-14 Dioxide

Determination of the plastochron, or time interval between the formation of successive leaf primordia, suffers from the difficulty of establishing the age of a primordium at any particular stage of development. An autoradiographic technique has been successfully used for obtaining an estimate of the plastochron of *Ranunculus* by indirect means.

The technique utilizes differences in amount of active material taken up by young leaves in different stages of development following administration of carbon-14 dioxide to one of the fully mature leaves. Two doses, at an interval of several weeks, are followed by a period in which the adjacent young leaves are allowed to grow to maturity. The leaves are then dried and exposed for two weeks to X-ray film, allowing the relative activity of successive leaves to be determined. Differences in uptake become evident as peaks of activity separated by a gap of leaves with lower activity. From the number of leaves between the peaks, the average rate of formation of successive leaf primordia can be calculated.

Ten plants of *Ranunculus hirtus* B. and S. were grown for four months under fluorescent lighting at 500 foot-candles intensity and at a temperature of

Table 1. Results of Plastochron Determination in *Ranunculus hirtus* B. and S. after labelling the Young Primordia with Carbon-14 Dioxide

| Time interval | Number of leaves between peaks | Plastochron in days |
|---|---|---|
| 67 days | 5 (1 plant) | 13·4 |
| | 6 (2 plants) | 11·1 |
| | 7 (3 ,, ) | 9·6 |
| | 8 (2 ,, ) | 8·4 |
| | 9 (2 ,, ) | 7·4 |
| | Mean plastochron 9·6 s.e. 0·59 | |

15° C. The second administration of $^{14}CO_2$ was made after 67 days, a further 43 days being allowed to elapse before contact autoradiographs were prepared (Table 1). Under these conditions the mean plastochron was found to be a little less than 10 days.

F. J. F. Fisher

Department of Plant Biology,
Carnegie Institution of Washington,
Stanford, California.
Aug. 20.

## Chasmogamous Flowering in *Viola palustris* L.

After a short burst of chasmogamous flowering in early spring, plants of *V. palustris*, like those of many other violet species, produce a succession of cleistogamous flowers throughout the summer. Such a change in flowering habit could be associated with changes in day-length, as in *V. fimbriatula* and *V. papilionacea* with which Allard and Garner[1] obtained chasmogamous flowers only in short days and cleistogamous flowers in long days. With several other violet species Chouard[2] has obtained chasmogamous flowering only in short day-lengths (for example, *V. odorata*), or after exposure to winter temperatures (for example, *V. silvestris*), or after both winter temperatures and subsequent short-day treatment (for example, *V. hirta*).

Experiments carried out in the Earhart Laboratory at Pasadena on members of five clones of *V. palustris* gave results that may be summarized as follows. Flower initiation may occur in plants under both short (8 hr.) and long (16 hr.) photoperiods, and also in continuous light. Plants kept in long days at a phototemperature of 20° C. and nyctotemperature of 14° C. (20°/14° C.) produced an abundance of large long-petioled leaves and of even taller peduncles bearing cleistogamous flowers, but never any chasmogamous ones. Plants transferred from long to short days continued to produce cleistogamous flowers for about two weeks: most of them then ceased flowering altogether, although a few plants later bore an occasional chasmogamous flower.

In short days the leaves were much smaller, round rather than cordate, and with short petioles; at 20°/14° C. most of the initiated flower buds did not develop, but nearly all plants produced occasional chasmogamous flowers, never any cleistogamous ones. In short days at higher temperatures no flowers of either kind were obtained, nor any at 17°/10° C. Several of the plants transferred from short days produced a few chasmogamous flowers when first moved to long days at 20°/14° C. before cleistogamous flowering began.

All the plants vernalized for eight weeks at 4° C. in short days of artificial illumination at 400 foot-candles intensity gave a short burst of chasmogamous flowering when transferred to 20°/14° C. in either short or long photoperiods. In long days this initial burst was followed by continuous cleistogamous flowering, in short days by no further flowering.

These results suggest a certain equivalence between short day-lengths and low temperatures in their encouragement of chasmogamous flowering in *V. palustris*, as also in the flowering of winter rye[3], and Chouard's results indicate that in some species the vernalization pathway, in others the short-day path, is the more effective, while in *V. hirta* the joint action of both is usually required. Allard and Garner considered that chasmogamy occurred only in conditions of reduced vegetative expression, which may account for the complete absence of chasmogamous flowers in short days at temperatures above 20°/14° C. where growth was more abundant. On the other hand, the fact that cleistogamous flowering was also absent in these conditions indicates clearly that the flowering habit is not simply an expression of the amount of growth made. Bergdolt[4] found that chasmogamous flowering of several violet species was favoured by a high nutrient supply; but in the present experiment all plants received a balanced nutrient solution every day, yet only cleistogamous flowers appeared in the continuous long-day treatments. Thus the effect of photoperiod on the type of flowering does seem to be specific, and not merely an indirect growth effect. However, the effect of vernalization and short-day treatments on the induction of chasmogamous flowering in *V. palustris* is strikingly ephemeral, few of the buds present during these treatments giving rise to chasmogamous flowers, which does suggest that the specific effects of short days and low temperatures on full flower development may be expressed only within a narrow range of growth conditions.

L. T. Evans

Division of Plant Industry,
Council for Scientific and Industrial Research,
Canberra.
Sept. 20.

[1] Allard, H. A., and Garner, W. W., U.S. Dept. Agric. Tech. Bull. 727 (1940).
[2] Chouard, P., *C.R. Acad. Sci., Paris*, **226**, 1831 (1948).
[3] Purvis, O. N., and Gregory, F. G., *Ann. Bot.*, N.S., **1**, 569 (1937).
[4] Bergdolt, E., *Bot. Abh.*, **20**, 42 (1932).

## Control of Watercress Crook Root Disease by Zinc-fritted Glass

Crook root disease of watercress (*Nasturtium officinale*, R.Br. and *N. officinale* × *N. microphyllum*, Boenn. ex Rchb.) was first reported in 1948 by officers of the National Agricultural Advisory Service. During 1949 the disease was found in all the watercress-growing districts, and it has now reached such serious proportions that it is a major threat to the industry.

The disease was found by Spencer and Glasscock[1] to be caused by a water-borne fungus (probably a species of *Spongospora*) which infects the roots and causes them to become swollen, distorted and 'crooked'. Infected plants lose vigour, become stunted and may eventually die. Investigations, since made by me, indicate that a practical control of the disease may be obtained by the addition of traces of zinc to the water in the watercress bed.

Laboratory studies on the disease were made by growing healthy rooted watercress cuttings in distilled water in glass jars together with watercress cuttings

bearing infected roots. The fungus in the infected roots liberated zoospores which infected the healthy roots, the cycle from infection to further zoospore liberation occurring in 8–10 days.

No infection could be obtained, however, when laboratory tap water at the Sub-centre of the National Agricultural Advisory Service, Wye, Kent, was used, although heavy infection was obtained using local spring water. The possible use of zinc in the control of the disease first became evident to me when analyses of the two waters, made by Dr. R. L. Mitchell of the Macaulay Institute, Aberdeen, showed that the tap water contained 1·8 p.p.m. zinc compared with 0·04 p.p.m. zinc in the spring water. The greater amount of zinc in the tap water was apparently caused by its flow through galvanized pipes.

Tests were made with zinc sulphate, and it was found that whereas 19·5 per cent of the primary roots and 12·5 per cent of the secondary roots became infected in distilled water, no primary roots and 0·03 per cent of the secondary roots became infected in zinc sulphate solutions containing 0·5 p.p.m. zinc. Infection was completely suppressed at a concentration of 2·0 p.p.m. zinc.

The use of soluble zinc compounds to control the disease in watercress beds presented practical problems caused by the large quantity of water passing through the beds (3–500,000 gallons per acre per day). These led to a search for relatively insoluble materials from which zinc would be liberated very slowly and which could be applied over the whole bed. One such material, a very insoluble zinc-containing glass-frit (zinc F.T.E.), has given promising results under field conditions.

Zinc frit consists of zinc oxide dissolved in glass which is then milled to a fine powder (< 250 mesh).

| | Composition of zinc F.T.E. (zinc frit) F.N.266 | | | | |
|---|---|---|---|---|---|
| | $SiO_2$ | $Fe_2O_3$ | $Na_2O$ | CaO | ZnO |
| Per cent | 55 | 4 | 16 | 2 | 23 |

The material is similar in type, though not in composition, to the fritted glasses used by Wynd[2] for supplying certain trace elements to plants.

Using the laboratory method described above, it was found that an amount as small as 0·05 gm. of zinc frit per 350 ml. water prevented infection. Comparative tests using two other frits, neither of which contained zinc, showed that these gave no control of the disease at amounts up to 0·2 gm. per 350 ml. of distilled water. This indicated that the effect of the zinc frit was due to its zinc content and not to the other constituents of the glass. This was substantiated by the fact that control was also obtained with 0·01 gm. zinc oxide and with 0·18 gm. powdered metallic zinc per 350 ml. of distilled water.

Field tests were then made in which zinc frit and two other non-zinc-containing frits were applied to three separate experimental watercress beds[3] in September 1955. These were treated with frits at the rate of 1 lb. per square yard; similar, adjacent, untreated beds, with common water supplies, served as controls. Zinc frit was also applied to two full-sized commercial beds in March 1956. They were divided longitudinally into three equal areas; the outer strips were treated with 1 lb. and ½ lb. of zinc frit per square yard respectively, and the centre, untreated strip was used as a control.

In all the trials, the plants in the beds were initially heavily infected with crook root. 4–8 weeks after treatments the watercress in the beds treated with zinc frit began to grow more strongly than that in the beds treated with the other frits and in the untreated beds. Very little or no crook-root infection could be found on the roots of the plants treated with zinc frit, whereas the control plants and the plants treated with the other frits remained heavily diseased.

These differences in growth and infection were still apparent eight months after treatment of the beds. The zinc content of the plants in the beds treated with zinc frit was somewhat higher than that of the plants in untreated beds; but the plants were still quite safe for human consumption. The zinc content of the outflow water from treated beds was less than that found to be toxic to fish in hard waters[4], such as supply most watercress beds.

Thanks are due to Messrs. Ferro Agricultural Division, Wombourn, Wolverhampton, for making and supplying the frits used in this study.

J. A. Tomlinson

National Vegetable Research Station,
Wellesbourne,
Warwick.
Sept. 26.

[1] Spencer, D. M., and Glasscock, H. H., *Plant Path.*, **2**, 19 (1953).
[2] Wynd, F. L., *Lloydia*, **14**, 1 (1951).
[3] Tomlinson, J. A., Ann. Rep. Nat. Veg. Res. Sta., 50 (1956).
[4] Jones, J. R. E., *J. Exp. Biol.*, **15**, 394 (1938).

## Molybdenum Deficiency in Hops

During the 1953–54 season, samples of leaves of hops showing chlorosis and breakdown, or a fine white speckling, of the lamina were received from a hop garden on the Motupiko soil type (*p*H 5·4–5·7) at Neudorf, Nelson (Fig. 1). Chemical analysis showed no important differences in zinc, copper and manganese contents between these leaves and those obtained for the many samples examined in this laboratory over a number of seasons. On the other hand, the molybdenum content of the affected leaves was 0·025 p.p.m. in the dry matter, which may be

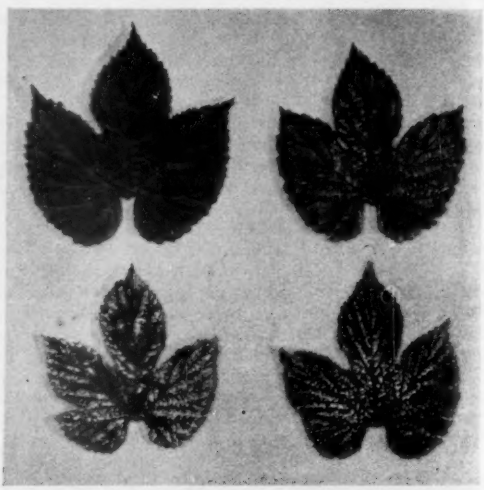


Fig. 1. Hop leaves; healthy leaf, top left; remaining leaves showing various grades of speckling

compared with 0·04 p.p.m. molybdenum for apparently healthy leaves in the same garden, and with the range of values, 0·08–2·1 p.p.m., for samples from other areas. In none of these latter samples was there any indication of abnormality in the leaves.

Because of the possibility that the unusual condition of the plants was due to a deficiency of molybdenum, a trial using sodium molybdate at 0·25 gm. per plant (250 gm. per acre), and ground limestone at 2 lb. per plant broadcast, singly and in combination, was set out on October 21, 1954. During the season, chlorosis and speckling of leaves were noted on a number of plants. By harvest time (March 1955), there was a very good favourable response to the molybdenum treatment, plants on plots receiving molybdate being mostly healthy with fresh green leafage. Limestone was beneficial. When used in conjunction with ground limestone, sodium molybdate was not so effective as when used alone. Chemical analysis showed that the improved condition of the leafage was positively correlated with an increased level of molybdenum in the laminæ.

This experiment was continued and enlarged in the 1955–56 season. The original plots, and new plots, were treated on October 25 with sodium molybdate to provide a rate of 1 lb. per acre on all the plots. On December 9 plants on the untreated areas of the original plots were mostly seriously affected by upward curling of the leaves with brown necrotic areas about 2 mm. in diameter, which later turned white, with leaves smaller and of a lighter green colour than normal. Where sodium molybdate was used, very satisfactory plants were produced. The effect of ground limestone was not completely satisfactory. For samples of laminæ taken on January 21, 1956, at a height of approximately 5 ft., from plants of the original series of plots, the following analytical data (p.p.m. molybdenum) were obtained: untreated, 0·12; limestone, 0·23; sodium molybdate, 1·03; molybdate plus limestone, 0·66. Although many of the plants on the untreated plots were showing severe symptoms, these did not generally extend above 5 ft. from the ground, so that most of the leaves in the untreated samples were apparently healthy.

Molybdenum content of the cones was increased by the use of sodium molybdate. Cones have been found to be richer in molybdenum than the corresponding leaf laminæ on both this deficient and other healthy areas.

On December 20, 1955, the plants were classified in percentages as follows, *H* referring to healthy and *T* to those showing only a trace of leaf symptoms: sodium molybdate, 90*H* and 10*T*; molybdate plus limestone, 67*H* and 33*T*; limestone, 42*H* and 42*T*; untreated, 6*H* and 22*T*. On the plots treated for only one season, the counts were: molybdate, 89*H* and 11*T*; untreated, 25*H* and 33*T*. These results show how completely the use of sodium molybdate has overcome the ailment, and confirm the diagnosis of molybdenum deficiency as the cause of the symptoms on the leaves.

Joyce Watson
H. O. Askew

Biochemistry Department,
Cawthron Institute,
Box 175,
Nelson, N.Z.
Sept. 19.

## The Olivine–Spinel Transition in the Earth's Mantle

From seismic data, Jeffreys[1] has inferred the presence of a discontinuity in the Earth's mantle at a depth of 400–500 km. Bullen[2] has found that between 400 km. and 900 km., a rapid increase in density occurs. It was suggested by Bernal[3], in conjunction with Jeffreys, that these findings could be explained by the assumption of a pressure inversion in the olivine of the mantle. Bernal suggested that, at high pressures, magnesium silicate might be inverted from an olivine to a denser spinel structure.

The Jeffreys–Bernal hypothesis has been investigated by a thermodynamic study of sub-solidus phase equilibria in the pseudo-binary system $Ni_2GeO_4$—$Mg_2SiO_4$ (Fig. 1). At 1,500° C., nickel germanate, which possesses a spinel structure, dissolves 9 per cent of magnesium silicate. From this and other similar data, the molar free energy of transition ($F$) of magnesium silicate from the olivine to the spinel structure may be calculated.

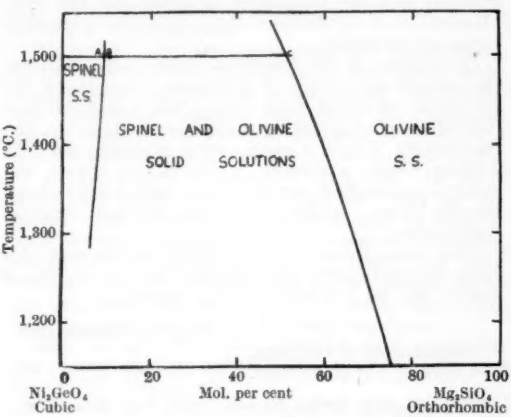



Fig. 1. Sub-solidus phase equilibria in the pseudo-binary system $Mg_2SiO_4$—$Ni_2GeO_4$

If $a_1$, $a_2$ are the activities of magnesium silicate in the spinel and olivine solid solutions in equilibrium, it is possible to show that:

$$F = RT \ln \frac{a_2}{a_1}$$

Assuming ideality and applying Raoult's law, $a_1$ and $a_2$ can be found from the compositions of co-existing phases in equilibrium. (The activity of $Mg_2SiO_4$ in a solid solution is given[4] by $[Mg]^2[Si]$ and not $[Mg_2SiO_4]$.) On this basis, a value for $F$ of 68,000 ± 10,000 joules/mole is found. The accuracy of this result depends upon the assumption of ideality. Theoretical considerations and further experimental work support this assumption.

The density of $Mg_2SiO_4$ spinel is obtained by extrapolating the densities of $Ni_2GeO_4$—$Mg_2SiO_4$ solid solutions. The transition is found to involve an increase in density of 11 ± 3 per cent. This value is supported by analogous studies of the density difference between cubic and orthorhombic magnesium germanate. The function $\int_0^P \Delta v \, dP$, where $\Delta v$ is the difference in molar volume, may be calculated for different pressures using reasonable assumptions as

to the compressibility of $Mg_2SiO_4$ spinel. This gives the difference in free energy of the two forms due to compression. When this reaches 68,000 joules, spinel becomes the stable form.

Calculation indicates that this value will be reached at a pressure corresponding to a depth of 520 ± 180 km. within the Earth. This is in good agreement with the depth of the 20° discontinuity found by seismology and is considered to provide strong evidence supporting the Jeffreys–Bernal hypothesis.

An olivine–spinel transition in the mantle is capable of explaining the variation with depth of density, elasticity and electrical conductivity. It is consistent also with the inference by Bullen[5] and by Birch[6] that the transition takes place over a wide range of depths. A substantial pressure interval would accompany the transition, because of the presence of other components in solid solution, particularly $Fe_2SiO_4$, $MgSiO_3$, $Ca^2$, $Al^3$, $Cr^3$. (Spinels are widely tolerant towards ionic substitutions and are often able to dissolve compounds with $ABO_3$ type formulæ.) The presence of a finite temperature gradient and the possibility of hysteresis and non-attainment of equilibrium also contribute towards a range of transition.

Occurrence of the transition raises difficulties for the convection theory of orogenesis, because of the liberation of latent heat during the transition and difficulties in maintaining equilibrium. However, the contraction theory is considerably strengthened. As cooling causes inversion of olivine to spinel, the volume contraction for the same heat loss is about twenty times greater than the normal thermal contraction.

This communication is essentially an abstract of a more comprehensive investigation[7] the full results of which will be published in due course.

A. E. Ringwood

Department of Geology,
University of Melbourne.

[1] Jeffreys, H., "The Earth", 3rd edit. (Camb. Univ. Press, 1952).
[2] Bullen, K. E., *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, **3**, 395 (1936).
[3] Bernal, J. D., *Observatory*, **59**, 268 (1936).
[4] Tempkin, M., *Acta Physicochim. U.R.S.S.*, **20**, 411 (1945).
[5] Bullen, K. E., "Introduction to the Theory of Seismology", Chapter 13 (Camb. Univ. Press, 1947).
[6] Birch, F., *J. Geophys. Res.*, **57**, 227 (1952).
[7] Ringwood, A. E., Ph.D. thesis, University of Melbourne (1956).

---

With great interest I have read the preceding important communication by Dr. A. E. Ringwood, which seems to confirm a hypothesis about a phase-transition of the olivine between the depths of 200 km. and 900 km. in the Earth, which I proposed (*Proc. Roy. Netherlands Acad. Sci.*, B, **59**, 1; 1956), starting from a different basis, namely, the overwhelming evidence in favour of convection-currents in the mantle. This demands the same chemical constitution throughout the whole mantle, and so we have to assume a phase-difference between the upper layer, above 200 km. depth, and the lower layer, below 900 km. depth, with a transition-layer between, in order to explain the density results, derived by Jeffreys, Birch and others on seismological grounds.

In this paper I tried to show that all the facts agree to this supposition, if at least the transition energy $K$ per gram is smaller than an upper limit given by

$$\left(\frac{K}{cA}\right)_m \leqq {}_l\theta_e - {}_u\theta_e$$

where the left-hand side is the mean value over the whole transition layer of the ratio of $K$ to the product of the specific heat $c$ and the heat equivalent $A$, while ${}_u\theta_e$ and ${}_l\theta_e$, respectively, are the values of the equilibrium temperature $\theta_e$ of the two phases, at the upper and lower boundaries, respectively, of the transition layer. For a value of $c$ of 0·20 (see "Handbook of Physical Constants" by Birch, Schairer and Spicer) the value of $K$ derived from Ringwood's result, namely, $F = 68{,}000 \pm 10{,}000$ joules/mole, would give:

$${}_l\theta_e - {}_u\theta_e \geqq 580° \pm 90°$$

As this value for the difference in temperature at 200 km. and 900 km. depth is acceptable, I cannot agree with Ringwood's conclusion regarding the incompatibility of the convection theory of orogenesis with the phase-transition hypothesis here presented.

In the paper mentioned above, I had occasion to make the following points. In the first place, the cooling of the Earth must bring about a broad transition-layer between the two phases, which slowly travels upwards; it now has reached the position between 200 km. and 900 km. depth. Secondly, the presence of convection currents which in this period of mountain formation we must surmise to rise below the continents, where the radioactivity of the sial must cause a higher temperature than below the oceans, and to subside below the oceans, must bring about a change of the denser phase into the lighter one below the continents, and the reverse below the oceans. This can explain the regressions of the continents during the first period of an orogenic cycle and the subsidence afterwards in the way indicated by the geological evidence. In the third place, this state of affairs can explain why in general the temperature gradient found below the ocean floors is about the same as that found below the continents, notwithstanding the difference of radioactive heat production in the two areas which might be expected to give a difference in gradient; the phase changes indicated must have a contrary effect on the gradient at the surface.

I may refer to the paper mentioned for some further evidence in favour of the hypothesis here presented. Dr. Ringwood's paper is a most important contribution to it, by giving a solid base for the phase-transition hypothesis.

F. A. Vening Meinesz

Mineralogisch-Geologisch Instituut,
Rijks-Universiteit,
Utrecht.

---

## Surface Adhesion and Elastic Properties of Mica

Consideration of the crystal structure of mica[1] suggests that the strong adhesive forces observed between mica cleavage surfaces may be the same as the forces which hold the alumino-silicate layers together in a block of the material. Cleavage occurs between two such layers along a plane of potassium ions, and the surfaces so formed may be flat and molecularly smooth over appreciable areas[2]. Apparently, both filled and empty potassium ion sites are present on the cleavage plane, but there is little

surface migration or diffusion of potassium ions. This is shown by the following experiment.

A sheet of muscovite mica was partially immersed in a solution containing radioactive cæsium chloride, rinsed and dried. The end of the sheet which had been immersed exhibited a counting-rate (Geiger–Müller counter) of the order calculated for the replacement of a half-filled layer of surface potassium ions by radioactive cæsium ions of the specific activity used, while the undipped end had a much lower activity. After the strip had been exposed to air at room temperature for three weeks, the counting-rates were found to be the same as they had been an hour after immersion. The presence of the surface ions, their ability to exchange with ions in solution, and the negligible diffusion of the ions either over the surface or into the bulk under these conditions is indicated.

If we assume that the adhesion is dominated by the presence of highly polarized potassium ions and the negative charges of their sites in the aluminosilicate framework, the energy required to cleave mica should be primarily that needed to overcome the coulombic attraction. Further, using the Born model for ionic crystals, the elastic properties in a direction perpendicular to the cleavage plane should be deducible from the same electrostatic forces.

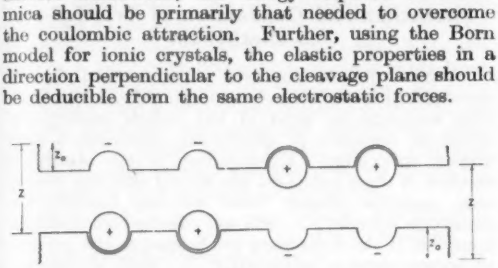


Fig. 1

Using a very simple model (Fig. 1) of potassium ions (+) and neighbouring sites of oxygen bearing a corresponding negative charge, we obtain for the force between a single ion and a single site the resultant of the electrostatic attraction and a repulsive term which decays more rapidly:

$$F = \frac{e^2}{z^2} - \frac{B}{z^n} \qquad (1)$$

Since the lateral spacing of the potassium ions and negative sites (about 5 A.) is large compared with $z$ (1·4 A.), only the immediate interaction of ion and site need be considered, that is, the Madelung constant may be taken as unity. Then the energy of separation is given by:

$$E = N \int_{z_0}^{\infty} \left( \frac{e^2}{z^2} - \frac{B}{z^n} \right) \mathrm{d}z \qquad (2)$$

where $N$ is the number of potassium ions per cm.$^2$ and $z_0$ is the equilibrium spacing in the crystal ($B$ is determined by the condition $F = 0$ at $z = z_0$). Using $N = 4{\cdot}2 \times 10^{14}$ as calculated from the crystal structure, $n = 7$, and $z_0 = 1{\cdot}4 \times 10^{-8}$ cm. (the radius of an oxygen ion—this is roughly equal to the distance between the potassium ion and the neighbouring plane of oxygen ions), we obtain $E = 5{,}750$ ergs/cm.$^2$. This crude value is within a factor of two of the value obtained by Orowan[3] from Obreimov's data for the cleavage of mica in vacuum. (It should be noted that Orowan computed a surface energy; we have calculated the energy required to effect separation of 1 cm.$^2$, producing 2 cm.$^2$ of surface.)

The elastic modulus perpendicular to the cleavage plane is given by:

$$M = N \left( \frac{\Delta F}{\Delta z / z} \right)_{z=z_0} = z_0 N \left( \frac{\mathrm{d}F}{\mathrm{d}z} \right)_{z=z_0} \qquad (3)$$

Using equation (1) for $F$ and inserting the values above, we find $M = 2{\cdot}5 \times 10^{12}$ dynes/cm.$^2$. Bridgman[4] estimated the modulus of mica in this direction to be $1{\cdot}7 \times 10^{12}$ dynes/cm.$^2$.

An extension of the adhesion-energy calculation can be made by assuming that in air a monolayer of nitrogen is adsorbed on each side of the cleavage plane. Introducing the dielectric constant of liquid nitrogen and increasing $z_0$ by twice the thickness of a nitrogen molecule (estimated from the density of liquid nitrogen), we arrive at $E = 618$ ergs/cm.$^2$, or about 309 ergs/cm.$^2$ of surface produced. This may be compared with Orowan's value for cleavage and re-adherence in air, 375 ergs/cm.$^2$.

The effect of liquid water in reducing the mica-to-mica adhesion is also readily understood, both the high dielectric constant and the occurrence of hydrogen ion–potassium ion exchange contributing to the reduction of attraction.

While the crudeness of this model and doubts about the accuracy of the experimental data cited make more detailed comparisons unwarranted, the qualitative agreement obtained emphasizes the important role of electrostatic forces in adhesion of mica. The results also indicate the need for more detailed studies of the properties of mica-like materials. It would seem that coulombic interactions can play an important part if the bonding is dominated by a highly polarized ion. In addition, there exists the interesting possibility of exchanging the surface ions after cleavage and so changing the surface properties of the material. Experimental work along these lines is in progress and will be reported elsewhere.

One of us (G. L. G.) acknowledges numerous interesting discussions with Dr. A. M. Bueche and Dr. B. H. Zimm.

GEORGE L. GAINES, JUN.
General Electric Research Laboratory,
Schenectady, New York.
DAVID TABOR*
(International Fellow, 1955–56)
Stanford Research Institute,
Menlo Park, California.
Aug. 31.

* Research Laboratory for the Physics and Chemistry of Surfaces, University of Cambridge.

[1] Bragg, W. L., "Atomic Structure of Minerals", 203–216 (Cornell Univ. Press, 1937).
[2] Bailey, A., and Courtney-Pratt, J. S., *Proc. Roy. Soc.*, A, **227**, 500 (1955).
[3] Orowan, E., *Nature*, **154**, 341 (1944).
[4] Bridgman, P. W., *Proc. Amer. Acad. Arts and Sci.*, **77**, 187 (1949).

## Dependence of the Dielectric Breakdown of Transformer Oil on Electrode Conditions

SEVERAL workers have found that the breakdown strength of an insulating liquid may be determined not only by its own composition and purity but also by the material and condition of the electrodes used to test it. Recent work in this laboratory is believed to show that the impulse breakdown strength of transformer oil is also dependent upon the thickness of the natural oxide layer on the surface of the electrodes.

Filtered, dried, and degassed oil has been tested in a totally enclosed test cell with micro-second duration impulse voltages of up to 500 kV. Hemispherical electrodes of 2·5 cm. diameter were used at a gap setting of approximately 2·5 mm., and were freshly prepared before each breakdown measurement. After polishing with a soft buffing mop and suitable cutting composition the electrodes were lightly buffed with a clean swansdown mop. This was followed by an examination under a metallurgical microscope to ensure that there were no heavy scratches or pits, after which the electrodes were placed in a desiccator containing a drying agent until required. When the oil had been filtered and degassed the electrodes were placed in position in the test cell, which was then evacuated to a pressure of $10^{-2}$ mm. mercury before the oil was admitted and the pressure increased to atmospheric in readiness for the test. A series of impulses were applied, increasing in magnitude from a low value in steps of about 1 per cent of the expected breakdown voltage, until breakdown occurred.

The first few tests, for which stainless-steel electrodes were used, gave very erratic results. Further investigation showed, however, that the recorded breakdown strength was dependent upon the time for which the electrodes were stored in the desiccator between the final buffing and their being placed in the test cell. When this time was controlled consistent results were obtained which could be reproduced to within $\pm 2$ per cent, but which showed an increase in strength with increasing storage time. Thus tests using electrodes which had been placed directly into the test cell after buffing gave a strength of 1,100 kV./cm., whereas tests in which electrodes which had been kept in the desiccator for more than 5 hr. were used yielded breakdown strengths in excess of 2,000 kV./cm.

Further tests showed that this variation in strength was dependent only upon the treatment of the cathode, and also that the effect was not observed if the electrodes were washed in hexane or acetone after buffing. The same increase in strength was obtained when the drying agent was removed from the desiccator. Tests with aluminium electrodes showed a similar breakdown effect; but in this case the strength varied from 890 kV./cm. for tests with electrodes which had been placed directly into the test cell after buffing, to a constant value of 1,310 kV./cm., when the electrodes were stored in the desiccator for 15 min. or longer. Time lag measurements made during these tests showed that breakdown occurred on or just after the peak of the impulse voltage wave-form.

The only acceptable explanation of the results reviewed above is that oxidation of the freshly prepared surface occurred while the electrodes were stored in the desiccator. The increase in the breakdown strength over a period of several hours when stainless-steel electrodes were used is consistent with results for the oxidation of stainless steel at room temperature, and the steady results obtained with aluminium electrodes which had been left in the desiccator for more than 15 min. also reflect the stable conditions found on an aluminium surface after that time. In order to explain the growth of the natural oxide layer on a metal surface under these conditions Mott[1] has suggested that chemisorption of oxygen on the surface results in a strong field in the oxide, of the order of $10^7$ volt/cm., and that this assists the reaction. This theory may be extended to show that under the conditions of the tests described above an electrical double layer exists on the surface of the cathode, the magnitude of which is proportional to the thickness of the oxide. This double layer would hinder the emission of electrons into the liquid and hence reduce the probability of breakdown.

I wish to acknowledge the receipt of a maintenance grant from the Department of Scientific and Industrial Research which enabled this work to be undertaken. It is intended to publish a more detailed account elsewhere.

R. Hancox*

High Voltage Laboratory,
Queen Mary College,
University of London.

* Present address: General Physics Division, Atomic Energy Research Establishment, Harwell.

[1] Mott, N. F., *Trans. Farad. Soc.*, **43**, 429 (1947).

## Photochemical Conversion of Triethyl-tin to Diethyl-tin

During the development of a method for the determination of organo-tin compounds[1] it was found that exposure to light of the yellow triethyl-tin–dithizone complex in chloroform produced a rapid change to orange. Examination of the absorption spectra of these solutions has shown that the absorption maxima change from 440 mμ (triethyl-tin–dithizone complex) to 485 mμ (diethyl-tin–dithizone complex) if the complexes are formed in the presence of borate–versene buffer *p*H 8·75. Both the diethyl-tin–dithizone and the irradiated triethyl-tin–dithizone complex change to one with an absorption maximum at 510 mμ upon the addition of one drop 10 per cent alcoholic trichloroacetic acid. Also, triethyl-tin–dithizone, diethyl-tin–dithizone and the irradiated triethyl-tin–dithizone complexes all dissociate upon the addition of one drop of glacial acetic acid to give the spectrum of dithizone. It seems certain that the triethyl-tin–dithizone complex is converted by light to the diethyl-tin–dithizone complex. There is a slow formation of diethyl-tin upon storage on the laboratory bench of a triethyl-tin solution in chloroform, though under these conditions it would take months to effect the conversion obtained in 1 min. in sunlight in the presence of dithizone.

The method for organo-tin compounds[1] estimates only triethyl-tin and diethyl-tin and excludes tetraethyl-tin, monoethyl-tin and stannic ions. After formation of the complexes in the presence of borate–versene buffer *p*H 8·75, absorption at 510 mμ is a specific measure of diethyl-tin in the presence of triethyl-tin. After the formation and measurement of the complexes glacial acetic acid may be added, the complexes dissociated and the total concentration of dithizone measured by absorption at 610 mμ. Quantitative measurements using low concentrations of dithizone (0·00067 per cent) indicates that the irradiation of increasing amounts of triethyl-tin produces increasing amounts of diethyl-tin, and increasing amounts of dithizone are destroyed. Quantitative measurements of the diethyl-tin complex using higher concentrations of dithizone, such that the loss of dithizone does not influence the amount of complex formed for a given amount of diethyl-tin, show that 1 mol. diethyl-tin is produced from 1 mol. triethyl-tin (Table 1).

Table 1

| Triethyl-tin irradiated (μm. moles) | Diethyl-tin formed (μm. moles) | Diethyl-tin / Triethyl-tin |
|---|---|---|
| 15·8 | 18·6 | 1·18 |
| 31·6 | 33·3 | 1·05 |
| 47·3 | 48·6 | 1·03 |
| 63·0 | 65·5 | 1·04 |
| 78·8 | 78·5 | 1·00 |

0–20 μgm. triethyl-tin sulphate in borate–versene buffer, *p*H 8·75 (ref. 1). were mixed with 6 ml. 0·0033 per cent (w/v) dithizone in chloroform. After allowing the layers to separate, the tubes were exposed to sunlight for 10 min., remixed with the aqueous layer, which was then removed and the absorption of the chloroform layer at 510 mμ read against a dithizone control. After reading, the chloroform layers were mixed with 3 ml. of a dilute aqueous solution of 2,3 dimercaptopropanol (this complexes very firmly with diethyl-tin (ref. 2)) and the absorption read again at 510 mμ. This allows a small correction to be made for the loss of dithizone due to the reaction.

These results are consistent with a reaction of triethyl-tin with dithizone to give diethyl-tin and eliminate a possible disproportionation of 2 mol. triethyl-tin to produce 1 mol. tetraethyl-tin and 1 mol. diethyl-tin. All the trialkyl-tin–dithizone complexes so far examined (trimethyl up to trihexyl) are similarly photochemically decomposed. Although there is a very slow production of diethyl-tin from triethyl-tin in chloroform without dithizone, we have no evidence that a neutralized solution of triethyl-tin sulphate in water produces any diethyl-tin upon storage. The liquid tetraethyl-tin slowly liberates triethyl-tin upon storage under laboratory conditions either neat or as a solution in chloroform.

W. N. Aldridge
Jill E. Cremer

Toxicology Research Unit,
Medical Research Council Laboratories,
Woodmansterne Road,
Carshalton, Surrey.
Sept. 26.

[1] Aldridge, W. N., and Cremer, J. E., *Analyst* (in the press).
[2] Aldridge, W. N., and Cremer, J. E., *Biochem. J.*, **61**, 406 (1955).

## A Method of promoting Water-forming Organic Reactions

The great reactivity of the boric acid esters with water is well known; moreover, recently even the equilibrium constants of their hydrolysis have been measured[1]. So far as is known to us, hitherto the borates have not been used for promoting water-forming (condensation) reactions.

The basis of our investigations has been to add the esters of boric acid to reaction mixtures which form water during the reaction, in order to shift the equilibrium in the direction of the desired product.

Esterifications were studied first. In preparing the ethyl and methyl esters of benzoic acid we observed a marked increase of the reaction velocity with high yields. Then we extended our method to the secondary esters, which are more difficult to prepare. In the presence of 0·11 mol. secondary butyl borate, 0·10 mol. benzoic acid and 0·11 mol. secondary butanol was refluxed for eight hours with 0·2 ml. sulphuric acid. Secondary butylbenzoate was isolated with an 82 per cent yield. In a similar manner, but in the absence of the borate, no ester was formed, the benzoic acid remaining unchanged.

It seemed interesting to prepare the benzyl esters of amino-acids by the same method. It is well known that these esters are important in peptide synthesis, and they are relatively difficult to prepare. In the presence of *p*-toluene-sulphonic acid[2], in carbon tetrachloride solvent at about 95° the corresponding amino-acid, benzyl alcohol and the benzyl borate were stirred for 4 hr. The *p*-toluenesulphonic acid salt of the amino-acid benzyl ester is crystallized by further addition of carbon tetrachloride, generally with an 80 per cent yield. Thus glycine, L-glutamic acid and threo-β-*p*-nitrophenylserine were esterified. Even in the case of glutamic acid the result was satisfactory.

The use of benzyl borates leads to almost quantitative yields in the case of peptides, for example, in the preparation of glycylglycine benzylester.

We have further used this method with another group of compounds in which we prepared acetals and ketals in the presence of borates. Benzaldehyde dimethyl acetal and diethyl acetal can be obtained with about 60 per cent yield. (Without adding the borates the yield is half this value.) The dimethyl ketal of cyclohexanone is prepared with a 65 per cent yield (without borate the yield is 30 per cent), and the diamyl ketal with a 40 per cent yield (without borate no ketal formed). The foregoing tests were carried out under reflux using 1 mol. of the carbonyl compound, 3 mol. alcohol and 1 mol. of borate with a small amount of hydrochloric acid.

This method may be considered useful for promoting other water-forming reactions. Details will be published elsewhere.

J. Kollonitsch
J. Vita

Research Institute for the Pharmaceutical Industry,
Rottenbiller-u. 26.
Budapest, 7.
Aug. 23.

[1] Bradley, J. A., and Cristopher, P. M., Abstracts of Papers 129th Meeting Amer. Chem. Soc., 39 *N* (1956).
[2] Cipera, J. D., and Nichols, R. V. V., *Chem. and Indust.*, 15 (1955).

## A Small Mercury Cut-off withstanding Large Pressure Differences

During the course of some work involving the handling of an easily adsorbed gas (ammonia) a number of taps and valves were tried and it was observed that all devices which incorporated greases, plastics or rubber were unsatisfactory owing to the large amount of gas adsorbed by these substances. It was a requirement that the valve for controlling the flow of gas should be vacuum-tight, withstanding a pressure difference between atmospheric pressure and $10^{-3}$ mm. mercury, have a minimal hold-up of gas and be small and suitable for attachment to a portable piece of apparatus.

The miniature mercury cut-off shown in Fig. 1 was designed and found to be satisfactory. It consists of a 1-cm. No. 4 porosity sintered glass disk *A* which could be immersed in mercury by screwing down on the pressure tubing *B* with a screw clip *C*. This action was made more effective by soldering on the lugs *D* to the cross bars of the clip, giving a larger area of contact on the rubber. It should be possible to raise the mercury by incorporating bellows or a syringe, but the method described was found to be satisfactory and easy of construction.

On filling the valve with mercury, care had to be taken to leave a sufficient gap between the mercury surface and the sinter, since under vacuum this surface rises owing to slight collapse of the pressure tubing.

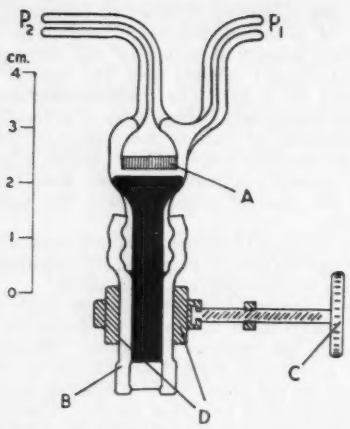



Fig. 1

If the pressure condition $P_1 \gg P_2$ was maintained, the valve was found to be vacuum-tight in the 'shut' position over a pressure difference of an atmosphere.

It was expected that very low pressures for $P_2$ would not be attainable, as with other sinter devices, but this is not always a necessity.

I thank Dr. V. Gold for much helpful discussion and Mr. H. Lee for help with the glass blowing.

H. Block

Chemistry Department,
King's College,
University of London,
Strand,
London, W.C.2.

## A Theory of Word-Frequency Distribution

The object of this communication is to show that a certain remarkably simple experimental relation governing word-frequencies in language can be explained by a simple model of the process of searching for information, about each word heard or read, in the memory of words employed in the language faculty.

The relation is as follows. If we suppose that $\varphi(\nu)$ is a distribution function giving the number of words in a given vocabulary occurring $T\nu$ times in a given text of $T$ words,

$$\varphi(\nu) = a/\nu^2$$

where $a$ is a constant, is found to be approximately true. This relation was pointed out by Zipf[1] and has been tested by one of us in the case of the Dewey word-count[2].

We now introduce the model which accords with this result, and proceed from the following hypotheses. The first three assumptions concern the process of searching in the memory for information about each word heard or read: (i) when searching for a word, the memory of words is scanned word by word, and only as much of the memory is scanned as is necessary to find the required word; (ii) in this process the words in the memory are scanned in order of decreasing frequency; (iii) the time required to scan a part of the memory of words is proportional to the number of words scanned. The fourth assumption concerns the language in question: (iv) a language will tend to evolve in such a way that the amount of information conveyed per unit of scanning time is a maximum.

It should be made clear that this scanning 'time' need not be physical time—it could be a monotonic increasing function of time: and we could have phrased the set of hypotheses in terms of 'room' occupied in the cortex by the memory of words, so that the average use of 'room' in scanning would be assumed to be minimized.

In order that assumption (iv) may be made strong enough to give a definite answer, we express it in the form that the frequency distribution of access-time is optimal over the whole of a finite range including the actual minimum. This makes the problem one of estimation which can be solved by an adaptation of the method of maximum likelihood. It is in fact reduced to the requirement that the condition, that the average access-time be a minimum, should provide an efficient estimate of the distribution function $\varphi$ referred to above.

We assume that this function exists and has been correctly estimated, so that the expression for its likelihood will be

$$\lambda = \sum_{w}^{W} T\nu_w \log T\nu_w \qquad (1)$$

where the summation is over all the $W$ words of the vocabulary. We now bring in two conditions: first, that the solution found be independent of the particular choice of vocabulary produced by a given text; this requires that not only the sum (1) but also each of its terms separately should be maximal; secondly, that the access-time for a word $w$ be proportional to the number of words the frequencies of which are not less than $\nu_w$, as follows from assumptions (i)–(iii) above; the access-time can therefore be expressed in the form

$$t_w = \int_{\nu_w}^{\nu_1} \varphi(\nu) \, . \, d\nu \qquad (2)$$

where $\nu_1$ is the frequency in the text of the commonest word.

Now, the conditions postulated reduce to the requirement that the mean of (2) over the whole text and vocabulary be inversely proportional to the likelihood (1), for then the condition of minimum access-time becomes identical with that of maximum likelihood. The resulting equation is

$$\frac{\int_{\nu_w}^{\nu_1} \nu.\varphi(\nu) \int_{\nu_w}^{\nu_1} \varphi(\nu) \, d\nu d\nu}{\int_{\nu_w}^{\nu_1} \nu.\varphi(\nu) \, . \, d\nu} = \frac{c}{T\nu \log T\nu} \qquad (3)$$

One solution of this equation is the given empirical law $\varphi(\nu) = a/\nu^2$. This can be shown by substitution, using as a principle of approximation that, except for the first few words, $\nu_w$ is small compared to $\nu_1$.

A. F. Parker-Rhodes
T. Joyce

Cambridge Language Research Unit,
20 Millington Road,
Cambridge.

[1] Zipf, G. K., "The Psycho-biology of Language" (Boston, 1935).
[2] Dewey, G., "Relative Frequency of English Speech Sounds" (Cambridge, Mass., 1923).

# FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

## Monday, December 10

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Mr. N. R. Hanson: "Newton and the Logic of Discovery".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "Unsolved Problems Arising from Automation", opened by Mr. G. L. E. Metz.

SOCIETY OF ENGINEERS (at 17 Victoria Street, London, S.W.1), at 5.30 p.m.—Annual General Meeting.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.45 p.m.—Dr. K. P. Oakley: "Dating Fossil Men" (Ramsden Memorial Lecture).

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. C. Musgrave: "Some Problems in the Colouring of Plastics".

## Tuesday, December 11

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

CEMENT AND CONCRETE ASSOCIATION (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. R. A. Foulkes: "The Construction of a Soil-Cement Runway at Christchurch, Hants"; Mr. T. B. Hill and Mr. K. H. G. Williams: "Soil Stabilized Pavements at Southend-on-Sea Municipal Airport"; Mr. F. R. Martin: "A Heavy-duty Airfield Pavement Embodying Soil Stabilization".

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at 6 Buckingham Gate, London, S.W.1), at 5.30 p.m.—Mr. W. H. Cashmore and Mr. J. C. Hawkins: "Tillage Equipment and Soil Conservation".

INSTITUTION OF THE RUBBER INDUSTRY, LONDON SECTION (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. M. G. Peakman: "Statistical Quality Control—a Non-Mathematical Treatment". 7 p.m.—"Industrial Rayon in Tyres and Belting" by Courtaulds Ltd.

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (joint meeting with the OILS AND FATS GROUP, at 14 Belgrave Square, London, S.W.1), at 5.30 p.m.—Mr. M. K. Schwitzer and Mr. D. Malcolm: "The Manufacture of Nitrogen Derivatives of Fatty Acids".

INSTITUTION OF MECHANICAL ENGINEERS, AUTOMOBILE DIVISION (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Mr. A. E. Moulton and Mr. P. W. Turner: "Rubber Springs for Vehicle Suspension".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Prof. A. J. Murphy: "Materials for Aircraft Structures Subjected to Kinetic Heating".

## Tuesday, December 11—Wednesday, December 12

SOCIETY OF CHEMICAL INDUSTRY, PESTICIDES GROUP (in the Auditorium, The Wellcome Building, Euston Road, London, N.W.1)—Symposium on "The Comparison of High and Low Volume Spraying Techniques on Fruit and Ground Crops".

## Wednesday, December 12

UNIVERSITY OF LONDON (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p.m.—Dr. R. I. S. Bayliss: "Laboratory Investigations in Endocrinology".*

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mrs. M. Wheatcroft and Miss Joan E. Walley: "Science in Kitchen Planning" (two papers).

PHYSICAL SOCIETY, COLOUR GROUP (in the Small Physics Theatre, Imperial College, Imperial Institute Road, London, S.W.7), at 3.30 p.m.—Symposium on "Colorimetry—Its Errors and Accuracy", introduced by Prof. W. D. Wright, Miss D. L. Tilleard, Mr. P. S. Williams, and Mr. J. W. Perry.

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. A. M. Quennell: "The Dead Sea Rift"; Prof. C. E. Tilley, F.R.S.: "The Melting Relations of Basalt".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. W. B. Douglas: "Effects of Maternal Employment on the Health and Development of Young Children".*

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO AND TELECOMMUNICATION SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. E. W. Hayes and Mr. H. Page: "The B.B.C. Sound Broadcasting Service on Very-High-Frequencies".

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in the Department of Psychology, Birkbeck College, Malet Street, London, W.C.1), at 6 p.m.—Mr. M. E. M. Herford, Miss M. W. Le Mare and Mr. Clive Williams: "The Young Worker in Industry".

CEMENT AND CONCRETE ASSOCIATION (joint meeting with the INSTITUTION OF STRUCTURAL ENGINEERS, at 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Dr. L. J. Murdock, Mr. W. J. Beckwith, Mr. D. D. Matthews and Mr. K. M. Wood: "Concrete Construction in the Soviet Union".

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL of the FOOD GROUP (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 6.15 p.m.—Prof. A. Neuberger, F.R.S.: "Some General Aspects of Protein Metabolism in Mammals".

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Dr. T. B. Tomlinson: "The Light Amplifier and Allied Devices".

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Dr. H. R. Ambler: "Corrosion in the Tropics".

INSTITUTION OF MECHANICAL ENGINEERS, STEAM GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "The Draft Code of Practice for Steam Turbine Installations".

SOCIETY OF INSTRUMENT TECHNOLOGY, CONTROL SECTION (at Manson House, Portland Place, London, W.1), at 7 p.m.—Dr. G. D. S. MacLellan: "Phase-plane Methods in Control System Design".

## Thursday, December 13

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGY and CHEMICAL ENGINEERING GROUPS (at 14 Belgrave Square, London, S.W.1), at 2.15 p.m.—Dr. S. Buchan, Prof. J. K. Baars and Dr. A. Key: "The Replenishment of Underground Water Supplies—Geological and Microbiological Considerations".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. A. Oppenheim: "Representations of Numbers by Various Algorithms".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. R. M. Finch: "The Use of Waste Materials". (Last of a series of six lectures on "The Conservation of Natural Resources".)

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "The Teaching of the Fundamentals of Transistor Circuits to Students of Electrical Engineering", opened by Mr. P. Godfrey.

CHEMICAL SOCIETY (in the Lecture Theatre, Royal Institution, Albemarle Street, London, W.1), at 7.30 p.m.—Prof. G. Gee, F.R.S.: "Physical Properties of High Polymers in Relation to their Chemical Structures" (Tilden Lecture).

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Dr. J. R. Busvine: "Insecticide-resistant Strains of Insects of Public Health Importance".

## Friday, December 14

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Captain G. T. Smith-Clarke: "Mechanical Breathing Machines" (James Clayton Lecture).

PRESTRESSED CONCRETE DEVELOPMENT GROUP (in the Lecture Theatre of the Institution of Civil Engineers, 5 Great George Street, London, S.W.1), at 6 p.m.—Prof. D. Vandepitte: "Recent Prestressed Concrete Construction in Belgium".

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Prof. A. R. Ubbelohde, F.R.S.: "Users of Power".* (Last of ten University Extension Lectures on "Technology and Industry".)

## Friday, December 14—Saturday, December 15

COMMITTEE OF VICE-CHANCELLORS AND PRINCIPALS OF THE UNIVERSITIES OF THE UNITED KINGDOM (in the William Beveridge Hall, University of London Senate House, London, W.C.1)—Conference of the Universities of Great Britain and Northern Ireland.

## Saturday, December 15

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, St. Mary's Hospital Medical School, London, W.2), at 10.45 a.m.—Scientific Papers.

---

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PHYSICS GRADUATE IN THE DEPARTMENT OF RADIOTHERAPY, for duties which include physical investigations concerned with the clinical use of rotation therapy, multicurie cobalt units, low voltage X-rays and radioactive isotopes, and also some teaching of radiographer students—The Assistant Administrator, The Churchill Hospital, Headington, Oxford (December 15).

PHYSICAL, ANALYTICAL and ASSISTANT CHEMISTS at the Central Electricity Authorities' Research Laboratories, Leatherhead, Surrey, for work on problems arising from the generation of electricity in conventional and nuclear power stations—The Director of Establishments, Central Electricity Authority, Winsley Street, London, W.1, quoting Ref. N/930 (December 19).

LECTURER (Grade I), and an ASSISTANT LECTURER, IN PURE OR APPLIED MATHEMATICS at the University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (December 21).

LECTURER IN AGRICULTURE (ANIMAL HUSBANDRY) at the University College of Rhodesia and Nyasaland—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (December 21).

LECTURER (with an honours degree or a higher degree in physics, and preferably teaching or research experience) IN APPLIED PHYSICS, at the New South Wales University of Technology, Sydney, Australia—The Agent General for New South Wales, 56 Strand, London, W.C.2 (Australia, December 27).

PROFESSOR (preferably experienced university teacher) OF GEOGRAPHY at the University of Ceylon—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (December 28).

POSTGRADUATE SCHOLAR (graduate in veterinary science, science or agriculture) IN VETERINARY SCIENCE—The Registrar, The University, Liverpool (December 29).

SCIENTIFIC OFFICER (CHEMIST) (with a first- or second-class honours degree in chemistry or equivalent, and preferably with experience in mineral analysis, spectrographic analysis, or modern physical methods of inorganic analysis) in the Colonial Office, Mineral Resources Division, London, S.W.7, for analytical and investigational work on minerals and mineral products—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.622/6A (December 29).

J. H. ANDREW RESEARCH FELLOW IN METALLURGY; UNITED STEEL COMPANIES' RESEARCH FELLOW IN METALLURGY; and TUBE INVESTMENTS RESEARCH FELLOW IN METALLURGY—The Registrar, The University, Sheffield (December 31).

LECTURER (with some teaching experience or experience as a research worker in pest control of plants) IN ENTOMOLOGY; and a LECTURER (with a good degree and some experience in plant pathology, either as a teacher or research worker) IN PLANT PATHOLOGY, in the Department of Agriculture, Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 1 Woburn Square, London, W.C.1 (December 31).

LECTURER or ASSISTANT LECTURER IN MATHEMATICAL STATISTICS—The Registrar, The University, Manchester (January 1).

LECTURER IN ORGANIC CHEMISTRY; and a LECTURER IN PHYSICAL CHEMISTRY—The Principal, Royal Holloway College (University of London), Englefield Green, Surrey (January 5).

RESEARCH FELLOW or SENIOR RESEARCH FELLOW IN DAIRY SCIENCE to carry out fundamental research on the problem of depressed butter fat percentage in cattle on certain diets—The Registrar, University of New England, Armidale, N.S.W., Australia (January 7).

RESEARCH FELLOW or SENIOR RESEARCH FELLOW IN POULTRY SCIENCE in the Faculty of Rural Science—The Registrar, University of New England, Armidale, New South Wales, Australia (January 7).

JOHN ELDER CHAIR OF NAVAL ARCHITECTURE—The Secretary of University Court, The University, Glasgow (January 11).

DRUMMOND FELLOWS FOR RESEARCH IN NUTRITION—The Honorary Secretary, Drummond Trust, University College, Gower Street, London, W.C.1 (January 31).

LECTURER IN BIOCHEMISTRY at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (January 31).

LECTURER (preferably with qualifications or experience in structural geology, stratigraphy, or quaternary geology) IN THE DEPARTMENT OF MINERALOGY AND GEOLOGY, University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, January 31).

READER or SENIOR LECTURER IN STATISTICS, at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 31).

ROBERT BLAIR FELLOW (British subject and at least 21 years of age) IN APPLIED SCIENCE AND TECHNOLOGY, for one year of advanced study or research abroad—The Education Officer (EO/WA.14), The County Hall, London, S.E.1 (February 28).

ASSISTANT CONSERVATORS (with a university degree in forestry) OF FORESTS, Sierra Leone—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.61/15/04.

HYDRAULIC ENGINEERS (B.Sc. (Eng.), and preferably subsequent experience in hydraulics) IN THE DEPARTMENT OF MINES AND NATURAL RESOURCES—Water Resources Branch, Province of Manitoba, Canada—The Agent General, Province of Manitoba, 8 Spring Gardens, London, S.W.1.

LABORATORY TECHNICIAN (A.I.M.L.T. or equivalent)—The North London Blood Transfusion Centre, Deansbrook Road, Edgware.

LECTURER IN THE DEPARTMENT OF AIRCRAFT ELECTRICAL ENGINEERING—The Recorder, College of Aeronautics, Cranfield, Bletchley, Bucks, quoting Ref. EP/L.

LECTURER (man or woman, with a horticulture qualification and preferably teaching experience) FOR RURAL SCIENCE, at the Cheshire County Training College, Alsager—The Director of Education, County Education Offices, City Road, Chester.

RESEARCH STUDENT (graduate in physics, engineering or aeronautics) to study the supersonic flow of gas through nozzles—R. P. Fraser, O.B.E., Chemical Engineering Department, Imperial College of Science and Technology, London, S.W.7.

SENIOR MECHANICAL ENGINEER (with an honours degree in mechanical engineering and have held a position of responsibility in engineering research or design) at the Central Electricity Research Laboratories, Leatherhead, Surrey, to take charge of the Mechanical Engineering Section responsible for investigating mechanical performance of materials and components, including static and dynamic stress analysis, vibration analysis, and the effect of fly-ash on the strength of concrete—The Director of Establishments, Central Electricity Authority, Winsley Street, London, W.1, quoting Ref. A.E.902.

SENIOR TECHNICIAN IN THE ZOOLOGY DEPARTMENT—The Secretary, Royal Holloway College, Englefield Green, Surrey.

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

Nuffield Foundation. Report for the year ended 31 March 1956. Pp. 160. (London: Nuffield Foundation, 1956.) [249

Empire Cotton Growing Corporation. Progress Reports from Experiment Stations, Season 1954–55. Tanganyika Territory, East Province. By R. Smith. Pp. 14. 9*d*. Survey of Reports. By Sir Joseph Hutchinson. Pp. 12. 9*d*. (London: Empire Cotton Growing Corporation, 1956.) [249

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 962. Vol. 249 (20 September 1956): Some Ergodic Theorems for One-Parameter Semigroups of Operators. By D. G. Kendall and G. E. H. Reuter. Pp. 151–177. 8*s*. 6*d*. Series B: Biological Sciences. No. 670. Vol. 240 (20 September 1956): Tooth Replacement in Mammal-Like Reptiles of the Suborders Gorgonopsia and Therocephalia. By K. A. Kermack. Pp. 95–133. 17*s*. 6*d*. (London: Royal Society, 1956.) [249

Federation of British Industries. Industry and the Technical Colleges: a Review of Some Current Problems. (F. B. I. Handbook.) Pp. iii+44. (London: Federation of British Industries, 1956.) 3*s*. [249

West of Scotland Agricultural College. Research Bulletin No. 15: Two-Year Leys for Silage. By I. V. Hunt and A. L. Gardner. Pp. 32. (Glasgow: West of Scotland Agricultural College, 1956.) [249

Report on Some Cyprus Soils. By D. A. Osmond. Pp. 81. (London: Colonial Office, 1954.) [249

British Iron and Steel Research Association. *Survey*, 1956 Issue. Pp. 16. (London: British Iron and Steel Research Association, 1956.) [249

## Other Countries

United States Department of the Interior: Geological Survey. Bulletin 1021–I: Geology of Devils Tower National Monument, Wyoming. By Charles S. Robinson. Pp. iii+289–302+plate 39. 50 cents. Bulletin 1027–B: Geology of the Crazy Woman Creek Area, Johnson County, Wyoming. By Richard K. Hose. Pp. vi+33–118+plates 7–13. 1.75 dollars. Bulletin 1027–H: Geology of the Christian Copper Mine, Gila County, Arizona. By Nels P. Peterson and Roger W. Swanson. Pp. iii+351–374+plates 33–43. n.p. Bulletin 1028–A: Geology of Pavlof Volcano and Vicinity, Alaska. By George C. Kennedy and Howard H. Waldron. Pp. v+20+plates 1–4. 65 cents. Bulletin 1033–D: Geophysical Abstracts 163, October-December, 1955. By Mary C. Rabbitt, Dorothy B. Vitaliano, S. T. Vesselowsky and others. Pp. iii+211–340. 25 cents. Bulletin 1039–A: Marl Deposits in the Knik Arm Area, Alaska. By R. M. Moxham and R. A. Eckhart. Pp. iii+24+2 plates. 50 cents. Bulletin 1039–B: Occurrence of Diatomaceous Earth near Kenai, Alaska. By George Plafker. Pp. iii+25–32+plates 3–6. 75 cents. Bulletin 1048–A: Geophysical Abstracts 164, January–March, 1956. By Mary C. Rabbitt, Dorothy B. Vitaliano, S. T. Vesselowsky and others. Pp. iii+92. 25 cents. Professional Paper 274–H: Palmlike Plants from the Dolores Formation (Triassic) in Southwestern Colorado. By Roland W. Brown. Pp. iii+205–210+plates 32 and 33. n.p. Professional Paper 276: The Stratigraphic Section in the Vicinity of Eureka, Nevada. By T. B. Nolan, C. W. Merriam and J. S. Williams. Pp. iii+78+plates 1 and 2. 1 dollar. Professional Paper 277: Stratigraphy of the Mascot-Jefferson City Zinc District, Tennessee. By Josiah Bridge. Pp. iv+76+2 plates. n.p. Professional Paper 278: Geology and Ore Deposits of the Baghdad Area, Yavapai County, Arizona. By C. A. Anderson, E. A. Scholz, and J. D. Strobell, Jr. Pp. iv+103+6 plates. n.p. Professional Paper 279: Cenozoic Geology of the Colorado Plateau. By Charles B. Hunt. Pp. iv+100. 75 cents. (Washington, D.C.: Government Printing Office, 1956.) [249

Carnegie Institution of Washington. Annual Report of the Director of the Department of Terrestrial Magnetism, 1954–1955. Pp. 54. (Washington, D.C.: Carnegie Institution of Washington, 1955.) [249

Centro Studi di Petrografia e Geologia del Consiglio Nazionale delle Ricerche, Presso l'Universita di Padova. Contributions to the Knowledge of the Flora of the Grey Limestones of Veneto: Part 1—a Revision of the *Flora Fossilis Formationis Oolithicae* of 'De Zigno. By Alan Wesley. (Memorie degli Istituti di Geologia e Mineralogia dell'Università di Padova, Volume 19.) Pp. 68+6 plates. (Padova: Istituti di Geologia e Mineralogia dell'Università di Padova, 1956.) [249

Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 115, No. 1: Notes on American Earthworms of the Family Lumbricidae, 3–7. By G. E. Gates. Pp. ii+46. Vol. 115, No. 2: A Quantitative Study of the Equidae of the Thomas Farm Miocene. By Robert S. Bader. Pp. 47–78. Vol. 115, No. 3: *Aneuretis Simoni* Emery, a Major Link in Ant Evolution. By E. O. Wilson, T. Eisner, G. C. Wheeler and J. Wheeler. Pp. 79–100+3 plates. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1956.) [249

*Editorial and Publishing Offices of "NATURE"*
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

*Advertisements only should be addressed to*
T. G. Scott & Son, Ltd., Crown House, 143–147 Regent Street, London, W.1
Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office